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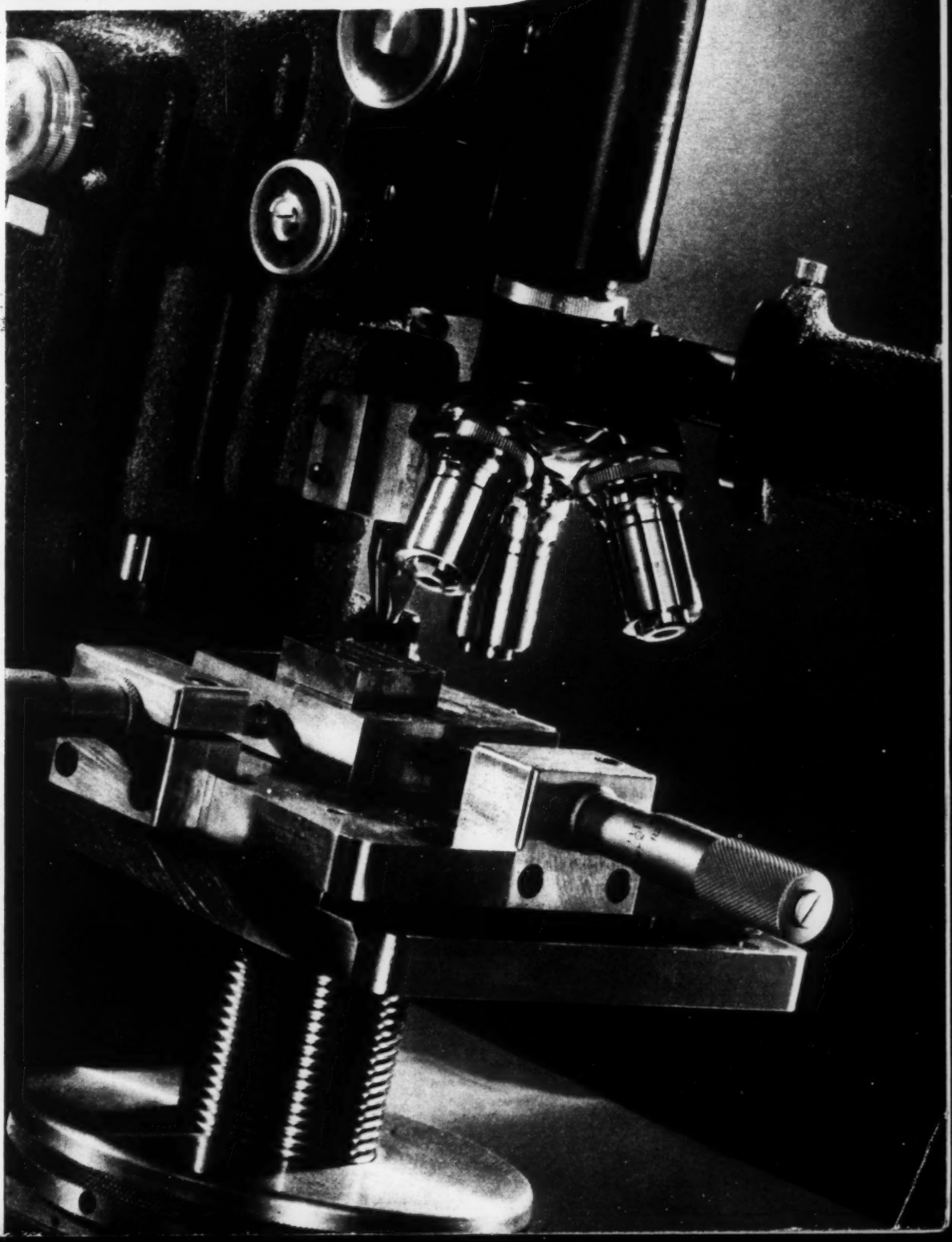
MACHINE DESIGN

November 1949



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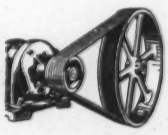

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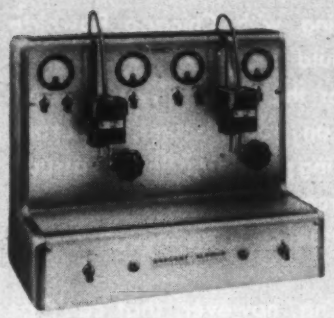

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This Month's Cover: Indentation type microhardness tester. Controlled indentation speed and unloading linkage for precision testing are discussed on Pages 146 and 147.

MACHINE DESIGN

Vol. 21—No. 11 November, 1949

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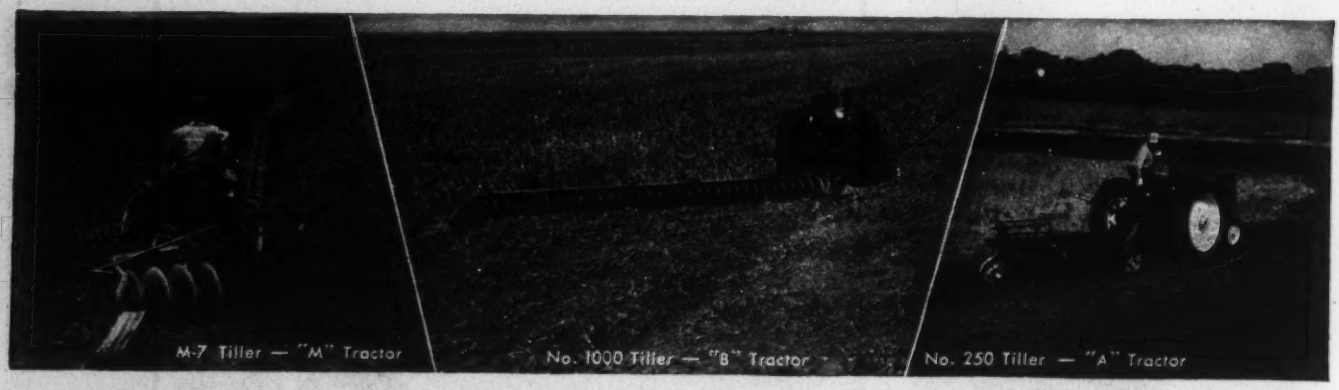

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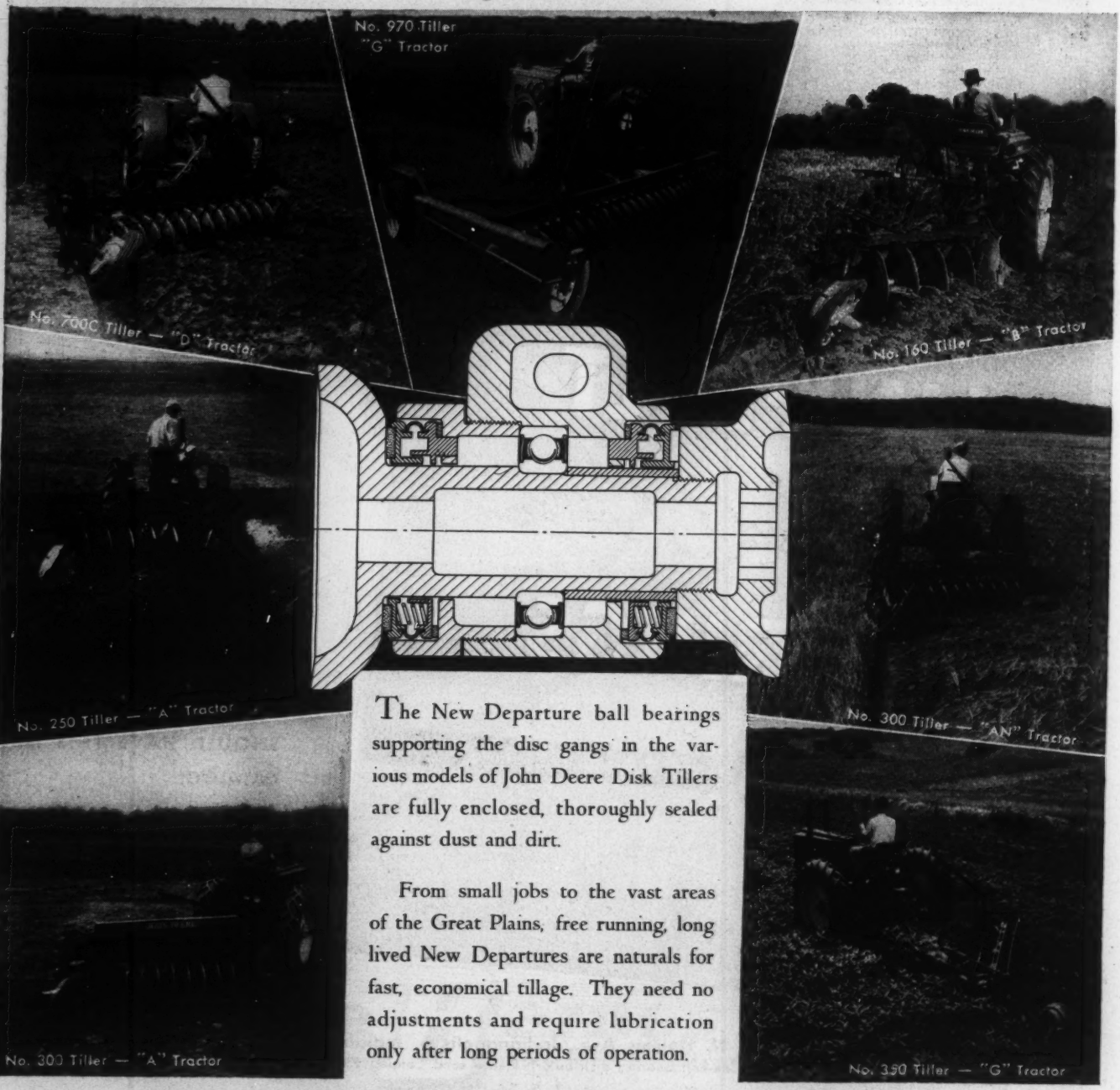

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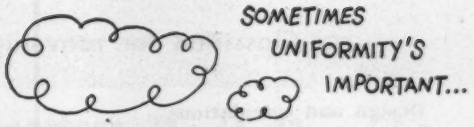

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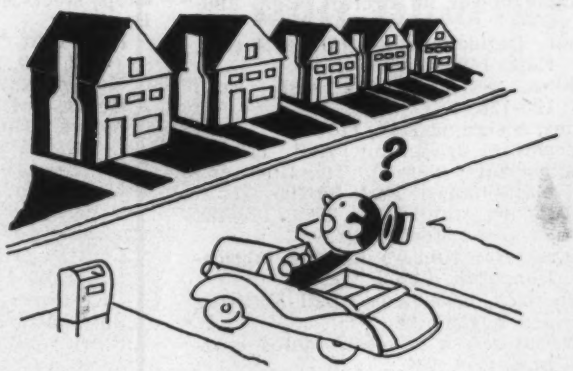

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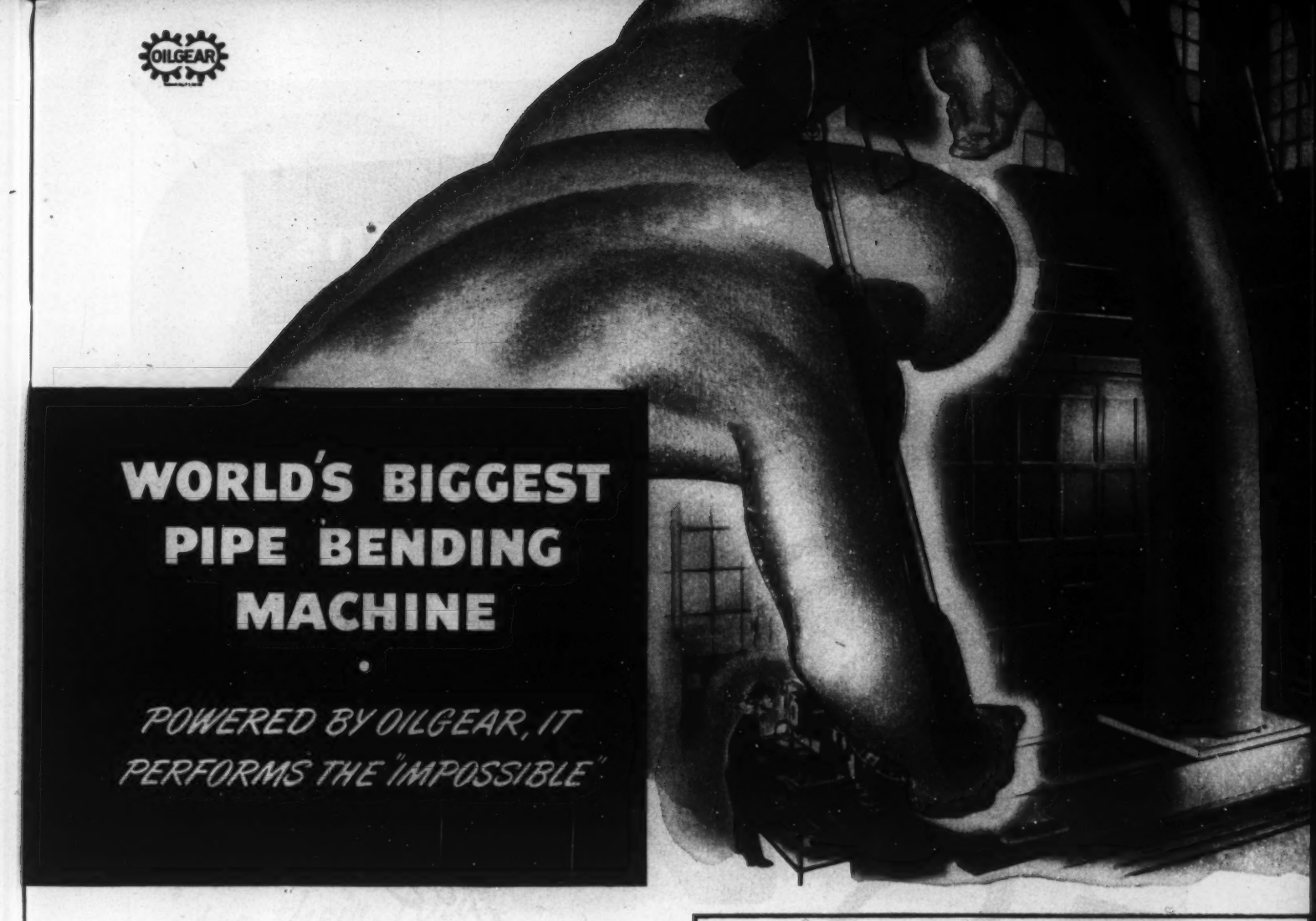

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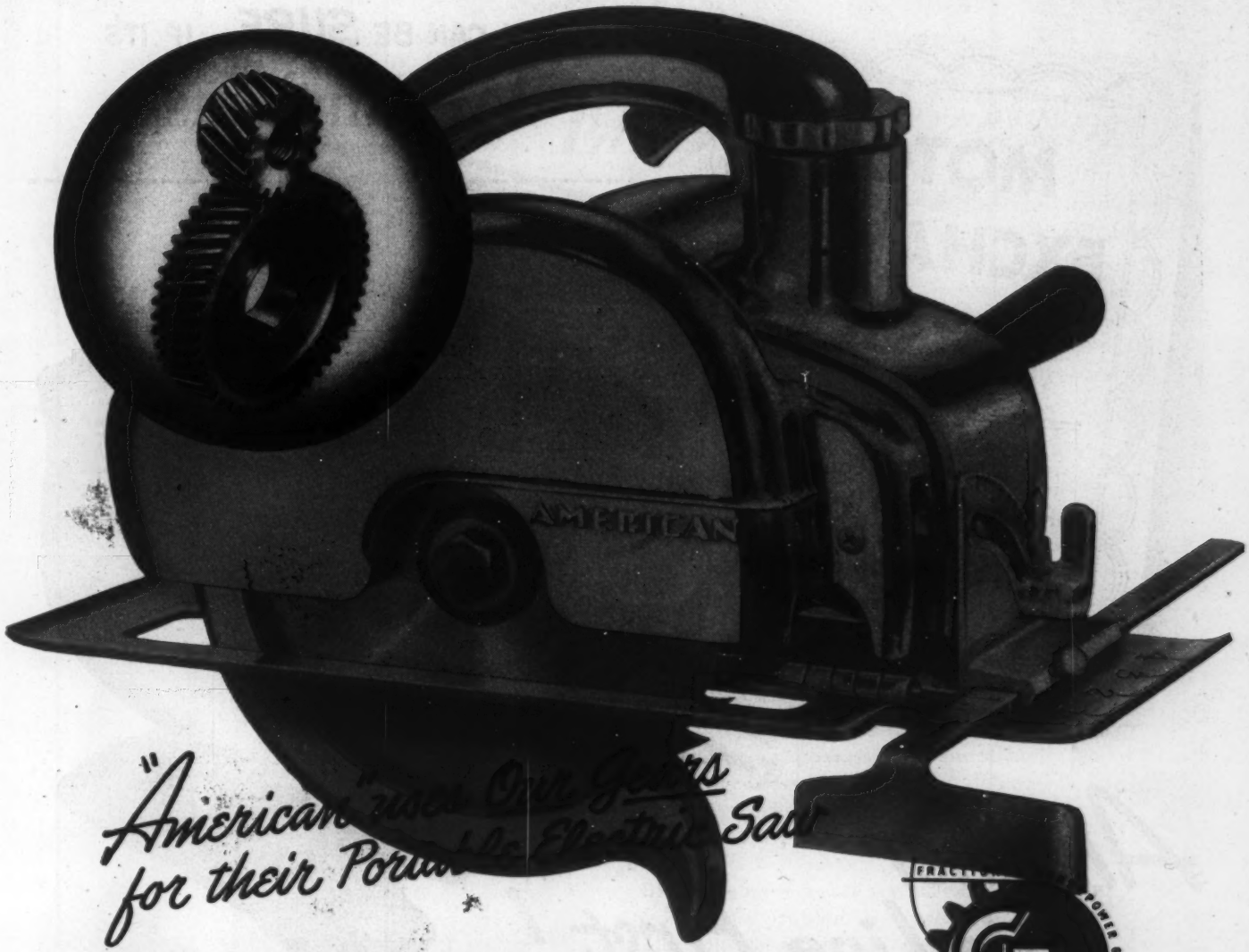

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This spindle bearing is standard equipment on large spindles designed by a world-famous builder of precision grinders. For extreme accuracy, for freedom from vibration, and for enduring precision, only sleeve bearings will do. Where other types of bearing retain their accuracy only for months, Bunting Spindle Bearings endure for years. Where other complex types require a surgical standard of cleanliness and a watchmaker's skill for replacement, the Bunting Sleeve Bearing requires only common-sense and the services of a good mechanic.

The secret of this performance and long life lies in the film type of lubrication. A properly designed and well lubricated sleeve bearing need not acknowledge any superior. No other bearing type possesses its simplicity, its ruggedness, its ability to deliver accurate work for many years. These attributes are possessed by the sleeve bearing.

Bunting engineers are at your service whether your problem is a precision grinder spindle, an aircraft engine, an automobile engine, or something of more or of less exacting requirements. Bunting engineers utilize their extensive experience with bearings of all types in their work of designing Bunting Cast Bronze Sleeve Bearings. The Bunting Brass & Bronze Company, Toledo 9, Ohio. Branches in Principal Cities.

Bunting

BRONZE BEARINGS

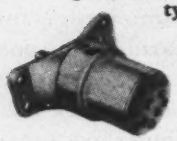
PRECISION BRONZE BARS

BUSHINGS

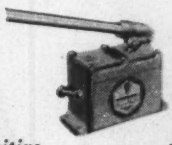
76

"I Bank on for Hydraulic Controls

"PUMPS . . . man alive, you should see how Blackhawk units pour horsepower into the job! Cold or hot weather is no bugaboo . . . and the low-price will astound you!"



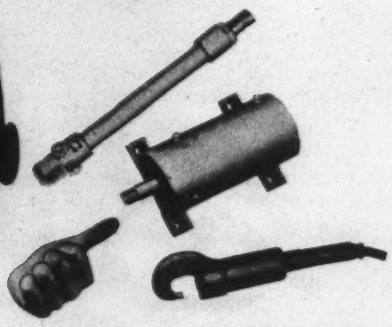
Yes, practically all the available horsepower goes *to work* when a Blackhawk *POWER-DRIVEN PUMP* is in action! In fact, with some units, volumetric efficiencies run over 90% at high pressures. The Blackhawk piston-type design gives you *positive* displacement — whether you need 1000, 2000, 3000, 4000 . . . *yes,* even up to 10,000 p.s.i.



No other pump in this field enjoys the sales record of "POWER-PACKER"! This famous Blackhawk *HAND-OPERATED* pump wins its way because of big exclusives, a service-proved reputation and attractive price. And now, you can get a "*Junior* Power-Packer"—at an even lower cost!

ASK FOR PUMP BULLETINS NOS. 1P, 2P, 3P AND 4P.

"RAMS have come to me from Blackhawk for 25 years — without field headaches! The leakproof designs are so simple and compact . . ."



What'll you have? Choose from *STANDARD, CATALOGED RAMS* — or order SPECIALS to answer the most unique purposes. You can get them in either single-acting or double-acting designs and in any length.

ASK FOR RAM BULLETIN NO. 1R.

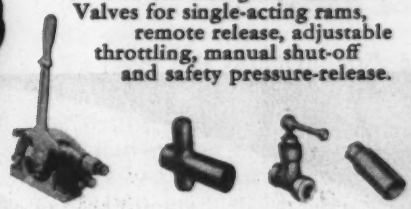
Scores of critical designers and buyers recognize that Blackhawk Hydraulics create exclusive advantages for the engineering, manufacturing and sale of their products. Many use *complete* Blackhawk systems, thus gaining extra and *unique* benefits from high-pressures — a field in which Blackhawk is a pronounced leader.

Blackhawk and Here's Why..."

"VALVES from Blackhawk spell precision control down to a molecule's whisker. They're positive-acting . . . and I can get single units or combinations to answer any and all of my needs . . ."

You'll find the new *"VALVBANK"* control system the last word for precision throttling on both raising and lowering. Standardized sections build into unlimited combinations—to serve either single-acting or double-acting rams, fluid motors or other hydraulic equipment.

You can also get Blackhawk Valves for single-acting rams, remote release, adjustable throttling, manual shut-off and safety pressure-release.



ASK FOR VALVE BULLETINS NOS. 1V, 2V AND 3V.

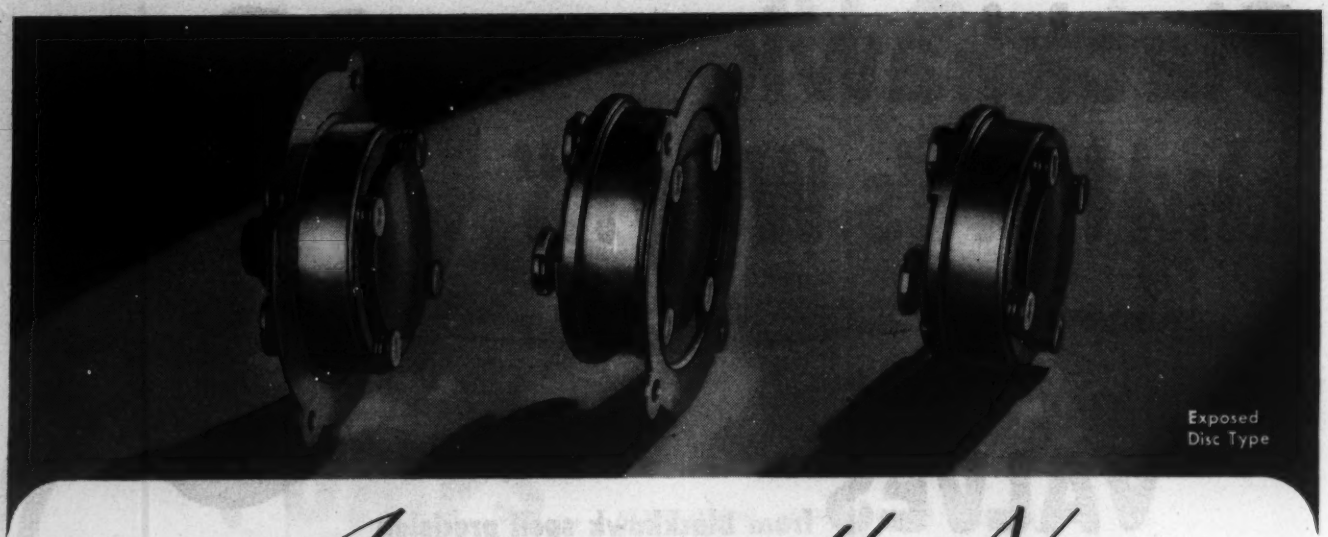
Expanded, Unmatched Facilities are here for building hydraulic equipment. Because of continuous production and widespread use, standard, cataloged components *are available from stock at attractive prices.* We also have the engineering and manufacturing facilities to develop and produce hydraulic equipment of special designs. We especially invite your requests for quotation on specialized *ram* requirements.

We invite you to write for free technical bulletins listed above—or, if you prefer, request them in the complete MASTER BINDER NO. OE which also contains helpful pictorial data on applications. Engineering Counsel is willingly furnished—in confidence. Blackhawk—the world's largest manufacturer of High-Pressure Hydraulic Equipment—welcomes inspection of its plant. **BLACKHAWK MFG. CO., 2020 S. 54th St., Milwaukee 1, Wis.**

BLACKHAWK

BLACKHAWK HYDRAULIC EQUIPPED

An Emblem Representing Dependability Throughout Industry



Announcing the New

KLIXON THERMOSNAP CONTROLS

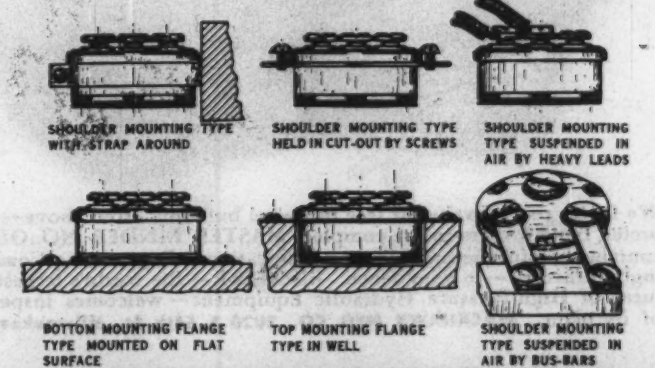
for products requiring non-adjustable Temperature Controls

The new Klixon, C4370 types, Thermosnap Controls are especially designed for such control applications as unit and space heaters, small water heaters and many other products requiring non-adjustable temperature control. These control units are available with enclosed contacts and exposed operating disc for fast thermal response . . . or with both contacts and thermal disc enclosed for greater protection against dust, oil, dirt, etc.

Klixon type C4370 Controls are listed by Underwriters' Laboratories for use where proper terminal enclosure is provided. This eliminates the need for further testing of the thermostat when applied to products requiring Underwriters' listing.

Klixon Thermosnap Controls can be supplied with various temperature differentials in settings from minus 10° to 550°F. . . . Manual reset type including reset button also available. They are simple to mount. (See typical mounting illustrations at right.) Write for information.

TYPICAL MOUNTINGS



KLIXON

SPENCER THERMOSTAT

Division of Metals & Controls Corp.

2511 FOREST STREET, ATTLEBORO, MASSACHUSETTS

Wichita City Library

Truly compressible gaskets reduce sealing costs on metal-to-metal joints

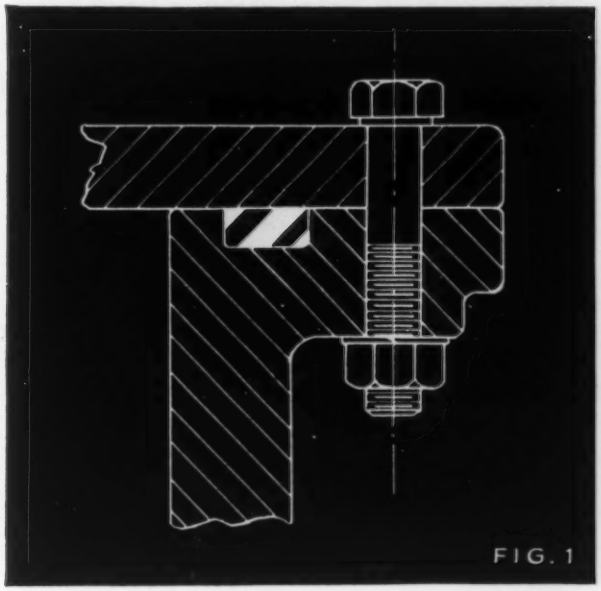


FIG. 1

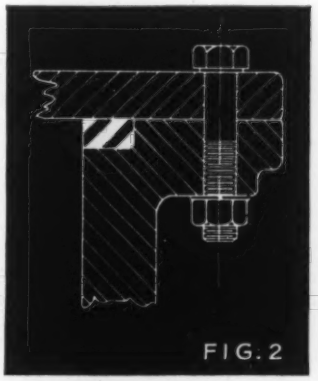


FIG. 2

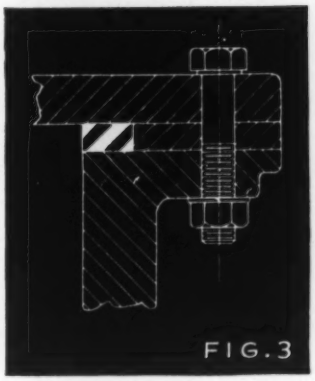


FIG. 3

Sealing costs on rigid, metal-to-metal joints frequently can be reduced with truly compressible gasket materials. Such materials compress under load, actually decreasing in volume. Hence they permit gaskets made to commercial standards to be used on units with extremely close assembly tolerances.

On the flange shown in figure 1, for example, sealing costs were reduced when its molded rubber gasket was replaced with a lathe-cut ring made of a truly compressible Armstrong's Cork-and-Rubber Composition.

Unless close tolerances were maintained, the rubber gasket tended to overflow its channel and interfere with correct mating of the flanges. Cork-and-rubber, on the other hand, compressed into the channel without extrusion. And because cork-and-rubber was lathe-cut instead of being molded, its cost was much less.

Similarly in figure 2, lathe-cut rings of Armstrong's Cork-and-Rubber replaced a rubber gasket and provided an effective, low-cost seal. Here again, tolerances on the rubber gasket had caused trouble. Undersize gaskets tended to creep out of place.

To solve this problem, cork-and-rubber rings were supplied 25% thicker than the depth of the counterbore. Because cork-and-rubber is truly compressible, it compressed without appreciable side flow and eliminated the tendency to creep.

Figure 3 shows how flat flanges were adapted to metal-to-metal sealing by inserting an annular shim between the flanges. As before, the lathe-cut cork-and-rubber gasket reduced sealing costs.

Effective, low-cost seals for units with close assembly tolerances is but one type of problem solved by Armstrong's Cork-and-Rubber. Call your Armstrong representative to see how these materials can help you.

Send for this Gasket Handbook

You'll find useful application and specification data in the revised 24-page booklet, "Armstrong's Gasket and Sealing Materials." It contains up-to-date data on synthetic rubber, cork-and-synthetic-rubber, and cork composition sealing materials.

This booklet includes ten technical discussions of the factors influencing modern gasket and joint design. It also suggests methods of putting Armstrong's stock materials to specialized uses in such fields as radio, electrical, automotive, petroleum, and transportation industries. Also included are typical applications and current government specifications.

For your copy, mail coupon today.

ARMSTRONG'S
GASKETS · SEALS · PACKINGS

Cork Compositions • Cork-and-Synthetic-Rubber Compositions
Synthetic Rubber Compounds • Cork-and-Rubber Compositions
Fiber Sheet Packings • Rag Felt Papers • Natural Cork

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Please send me at once a free copy of the new 24-page booklet, "Armstrong's Gasket and Sealing Materials."

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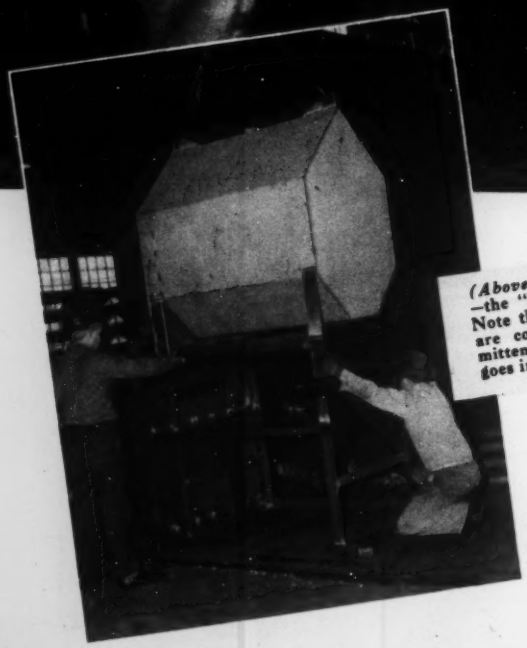
Who said it costs more to use Stainless Steel?

FAMOUS DRAVO USES STAINLESS

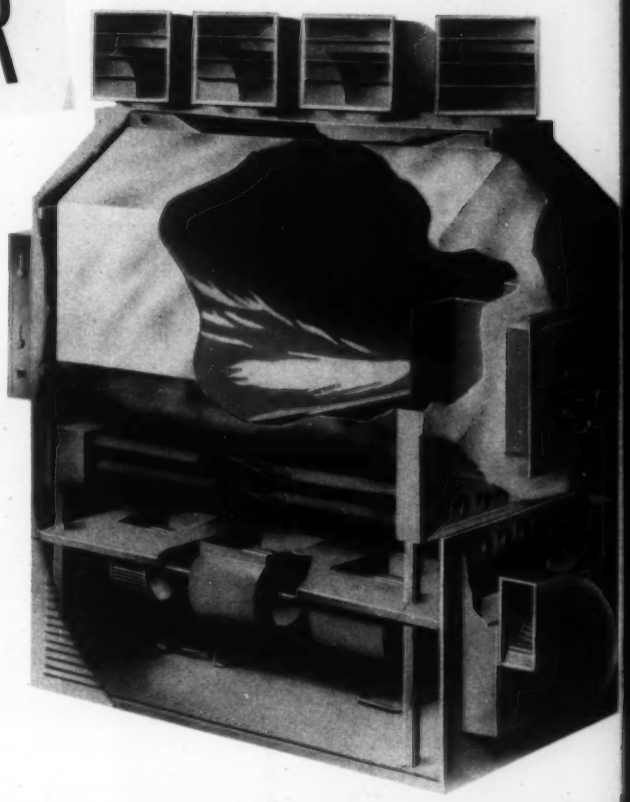


(Above) The Stainless Steel combustion chamber —the "heart of the heater"—takes finished shape. Note the simplicity of construction. Outer seams are continuous-welded, inside seams are intermittent. *(At left)* The completed Stainless chamber goes into the frame as a unit.

(At right) Outer casting goes on. Fastened with sheet metal screws, panels can be easily and quickly removed. Asbestos gaskets make joints air-tight. Mass production methods insure uniform, speedy manufacture.

Counterflo HEATER

TO REDUCE COSTS!



Completely self-contained, automatic in operation, this direct-fired heater provides an entirely new solution to the troublesome problem of plant heating. A "single-package" heating unit that can be positioned anywhere, it supplies heat directly to the area needing it, efficiently and economically.

Incidentally, it also proves that using Stainless Steel does not necessarily increase cost, but on the contrary, can decrease it.

THE heart of any heater is the combustion chamber. In the original Dravo Heater sold by the thousands to army camps and plants during the war, this chamber was made of corrugated carbon steel lined with refractory cement. Numerous fins and deflectors were welded to its outer surface.

To meet the tremendous civilian demand created by its highly successful war-time service, Dravo engineers recently redesigned the heater to increase its efficiency, to reduce its size and weight, to increase its life span, to make its operation safer. And in order to maintain prices in the face of rising labor and material costs, they took steps to speed up its production and to reduce manufacturing costs. They accomplished these things mainly by building the combustion chamber of Stainless Steel.

By specifying Stainless Steel that withstands temperatures up to 1600°F. they got rid of the troublesome and maintenance-demanding refractory lining. The unlined chamber, with its entire surface now exposed to the flame and gases, greatly increased heat transfer. This made it possible to eliminate fins and deflectors, allowed them to build the chamber smaller (to reduce its heating surface 53% without reducing operational performance) . . . and to reduce its weight 1500 pounds.

In addition, the simplified chamber design obtained by the use of Stainless Steel reduced the number of fabricating operations from 95 to 67. And, even though welding with Stainless requires more care, welding costs too were reduced because only 186 lineal feet of welding were required instead of 400 feet.

• To indicate how U·S·S Stainless Steel might benefit *you* in similar constructions, we recapitulate the benefits Dravo has obtained by using Stainless:—It has enabled them to employ less expensive manufacturing procedures than those used previously. It has insured greater portability for their equipment. It has improved heat transfer and eliminated expensive refractory maintenance. Dravo is now sold on the use of Stainless Steel because, as their engineers report, it has given them a tremendous advantage over competition in many respects, one of the most important being *lower cost of manufacture.*

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH & CHICAGO
COLUMBIA STEEL COMPANY, SAN FRANCISCO · NATIONAL TUBE COMPANY, PITTSBURGH
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

United States Steel Corporation Subsidiaries
Room 2069 Carnegie Building, Pittsburgh 30, Pa.

☐ Please send me the new book, "An Introduction to U·S·S Stainless Steel."

☐ Please have a Stainless representative call on me.

Name.....

Position.....

Company.....

Address.....

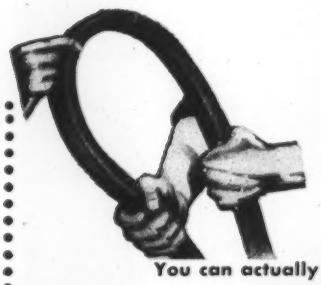
City..... Zone.... State.....

USS

U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

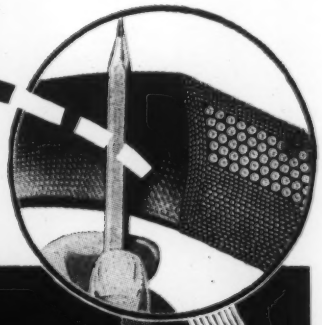


You can actually *feel* the sides of a belt *change* shape as the belt bends.

In Two Minutes You Can See Exactly How . . .

The Concave Side

(U.S. Patent No. 1813698)



SAVES Your Transmission DOLLARS

Take *any* V-belt in your hands and bend it as it bends in going around a pulley. You will see that the top of the belt, being under *tension,* grows *narrower.* The body, under compression, *widens.* The sides *bulge out.*

This shape change—in a *straight-sided* V-belt—is shown in Figures 1 and 1-A, below.

Straight-Sided V-Belt

How Straight-Sided V-Belt Bulges in Sheave-Groove.

Now look at Figures 2 and 2-A. There you see how the *same shape change* affects the V-belt built with the precisely engineered *Concave Side* (U.S. Patent No. 1813698).

Gates Vulco Rope with Concave Side.

No Side Bulge. Precise Fit in Sheave Groove.

The top of the belt narrows, the body widens. But the sides *merely straighten—and* the new shape *exactly fits* the sheave groove!

Two savings result. (1) Uniform side-wall wear *—longer life!* (2) Full side-wall grip on the pulley carries heavier loads and *sudden load increases* without slipping; saves belts, saves *power!*

REG. U. S. PAT. OFF.

The Mark of SPECIALIZED Research

The Concave Side is *MORE IMPORTANT NOW Than Ever Before*

Because the sides of a V-Belt are what actually drive the pulley, it is clear that any increased load on the belt means a heavier load that must be transmitted to the pulley directly through the belt's sidewalls.

Now that Gates SPECIALIZED Research has made available to you SUPER Vulco Ropes—carrying fully 40% higher horsepower ratings—the life-prolonging Concave Side is naturally more important in conserving belt life today than ever before.

4910

GATES VULCO ROPE DRIVES

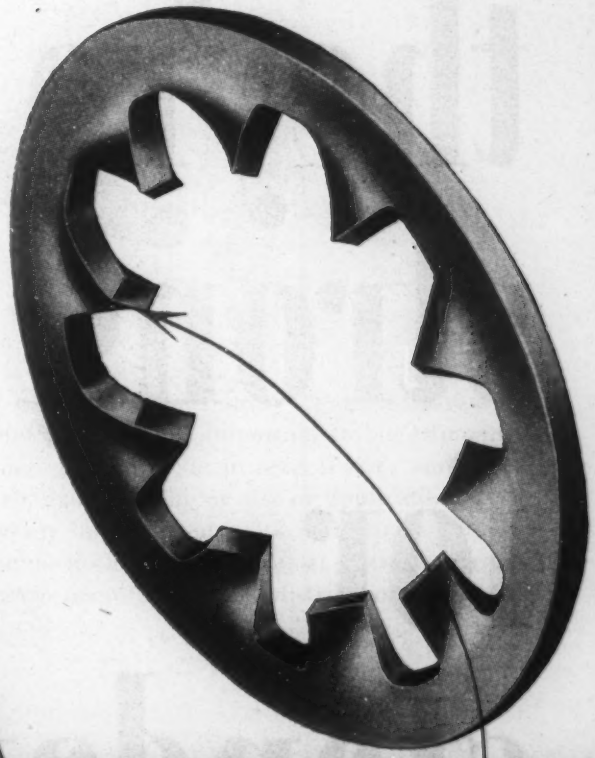
Engineering Offices and Jobber Stocks IN ALL INDUSTRIAL CENTERS of the U. S. and 71 Foreign Countries

THE GATES RUBBER COMPANY

DENVER, U.S.A.

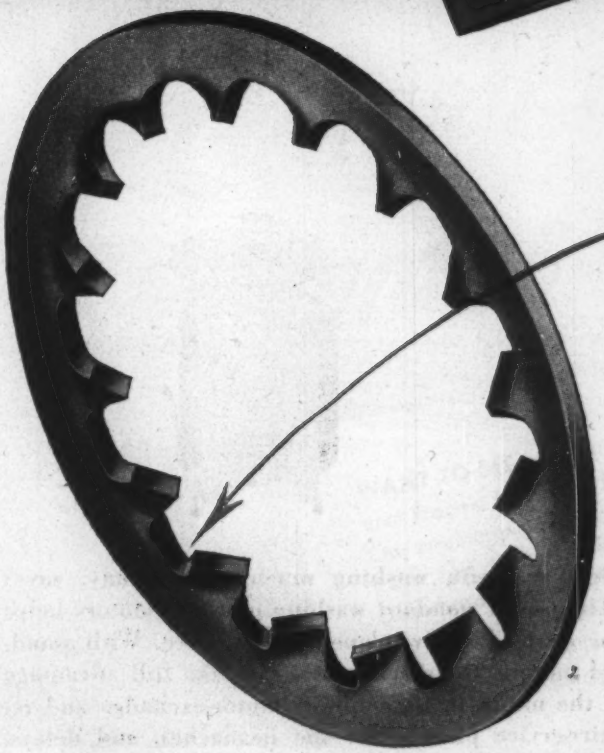
The World's Largest Makers of V-Belts

DISCOVER THE SAVINGS IN *specially designed* LOCKING POWER



WRITE FOR THIS FREE BOOK!

Investigate the cost-saving and performance-improving advantages of engineered Shakeproof Lock Washers!



Look-alikes don't always work alike. For example, the Internal Type Shakeproof Lock Washer shown above has a standard rim and standard number of teeth for use under standard ½" nuts. The Internal Lock Washer at left is a special *thin-rimmed* washer with *more* locking teeth for specific use under ½" conduit nuts in electrical assemblies.

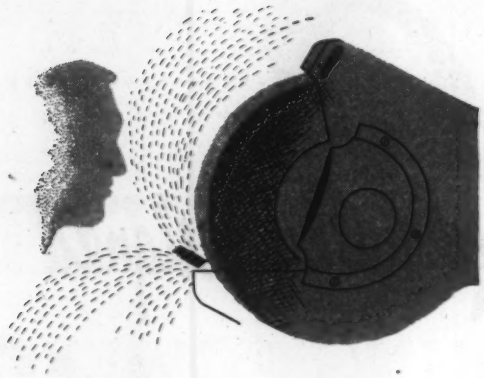
Knowing when and how to apply the standard and special types and sizes of Shakeproof Lock Washers will mean increased fastening efficiency and lower assembly costs to you. And, that's what this new book on Shakeproof Lock Washers is for . . . with illustrations and typical applications of all the Shakeproof Lock Washer types, an explanation of the locking principle and handy size data! See what Shakeproof Lock Washers can do in your specific application. Write for your free copy today!

SHAKEPROOF inc., Division of Illinois Tool Works, 2501 North Keeler Avenue, Chicago 39, Illinois. In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario.

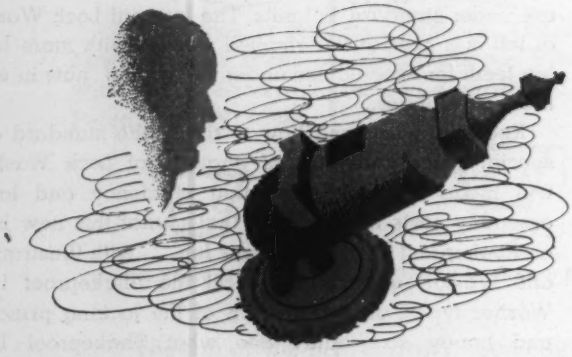
FASTENING HEADQUARTERS
TRADE MARK

Shakeproof LOCK WASHERS

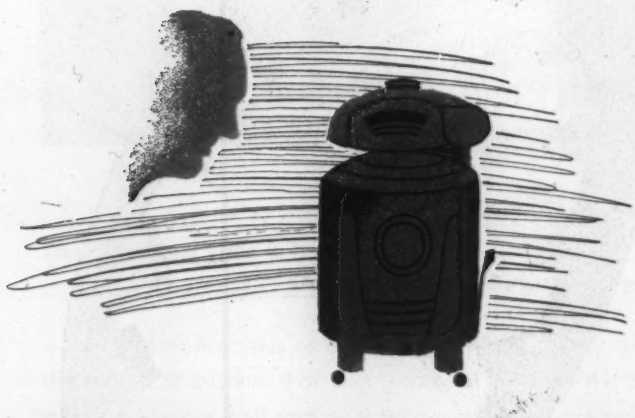
they're strong for standardization



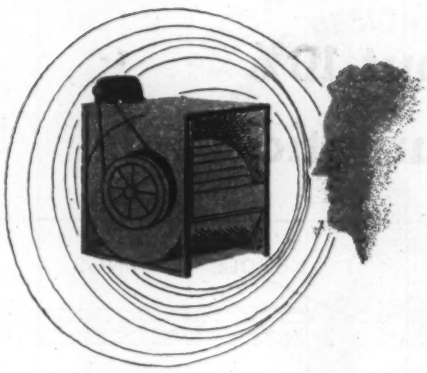
Electrical Engineer, machine tool company, says: "I think designers will save time in the long run if they decide, at the start of a job, to use standard motors. We'll eliminate exhaustive engineering tests we used to make on fractionals. With horsepower, service factor, breakdown torque, and starting current all rated on a clear-cut, uniform basis we'll know *in advance* that the motor will do the job."



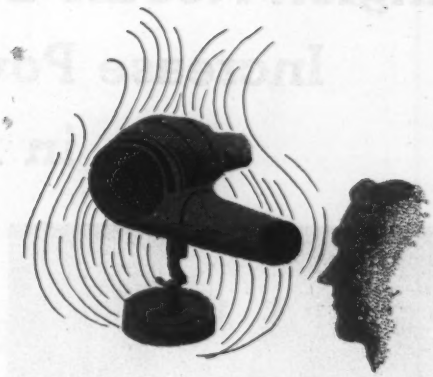
Chief engineer, portable tool plant, says: "I simplify design when I specify series-motor parts with NEMA standard dimensions for our portable tools. By designing tool housings to take parts conforming to these standards, I simplify case construction, obtain interchangeable motor design, and lower overall costs."



Vice-President, washing machine company, says: "The use of *standard* washing machine motors helps our dealers to give dependable service. With standard motors, the service man can take full advantage of the motor manufacturer's motor-exchange and repair-service plans—take the headaches, and delays, out of motor repairs or replacement. He can be sure that the motor he puts back on the job will perform as it should."



President, electric blower corporation, says: "The big thing about the new fractional-hp motor standardization plan, to me is that we stand a better chance of getting 'off-the-shelf' delivery of motors when they are a big-production item, instead of a special. Also, we eliminate special jigs and fixtures, and the need for making universal mounting bases and adapter plates."



Head of oil burner firm says: "Standardization of motors and parts is most important to our company. Our burners can be made in several sizes and types without changing the motor size or application, even when making improvements and new models. Standardization means lower production and inventory costs for oil burner manufacturer and distributor or dealer."

They use General Electric Standardized Motors

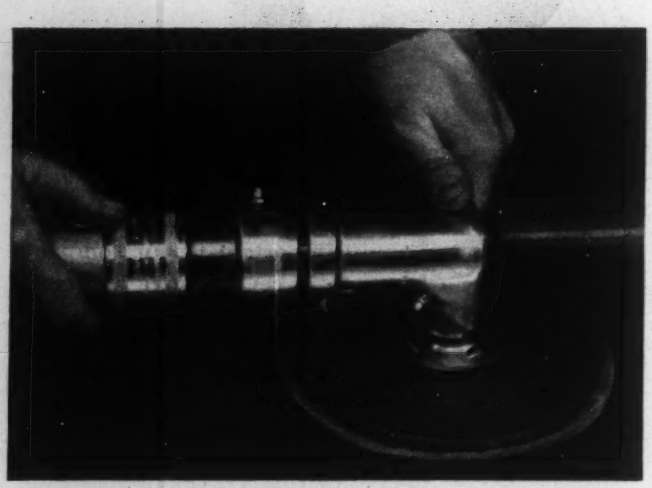
FRACTIONAL HORSEPOWER

WANT TO SEE whether a switch to standardized General Electric fractional-hp motors will pay off for you? Our engineers will be glad to give you the unvarnished facts. Just drop us a line giving the size, type and special characteristics of the motors you are now using. For general information about fractional-hp motor standards write for Bulletin GES-3565. Apparatus Department, General Electric Company, Schenectady 5, N. Y.

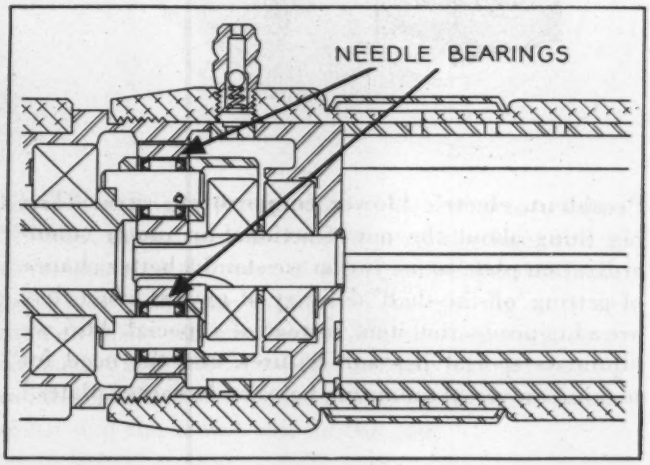
GENERAL ELECTRIC

700-99

Torrington Needle Bearings Increase Power Output 10% in ARO Pneumatic Tools

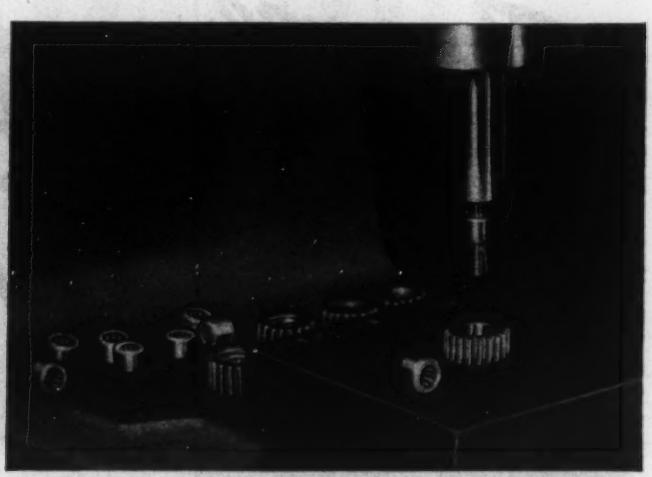


By Applying Torrington Needle Bearings in the planetary gears of the Model 7099 Screwdriver and Model 7095 Sander, Aro Equipment Corporation, Bryan, Ohio, increased power output 10%. This increase in efficiency, determined by special tests, is accompanied by reduced lubrication and maintenance, and longer service life.



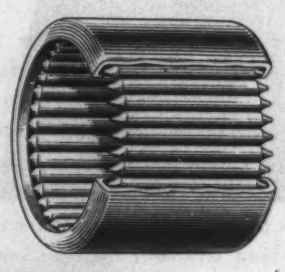
No Major Design Changes were needed to adapt Needle Bearings to this application, shown above in cross-section. These compact anti-friction units met the space and weight limitations ideally, with no sacrifice of reliability. The full complement of small diameter rollers assures tremendous radial capacity.

Service Life Tests were run for as much as ten times the normal life of the tools. Previously, the planetary gears, shown above, had been a trouble spot—but the Needle Bearings and the pins that serve as shafts showed no appreciable wear when tests were completed.



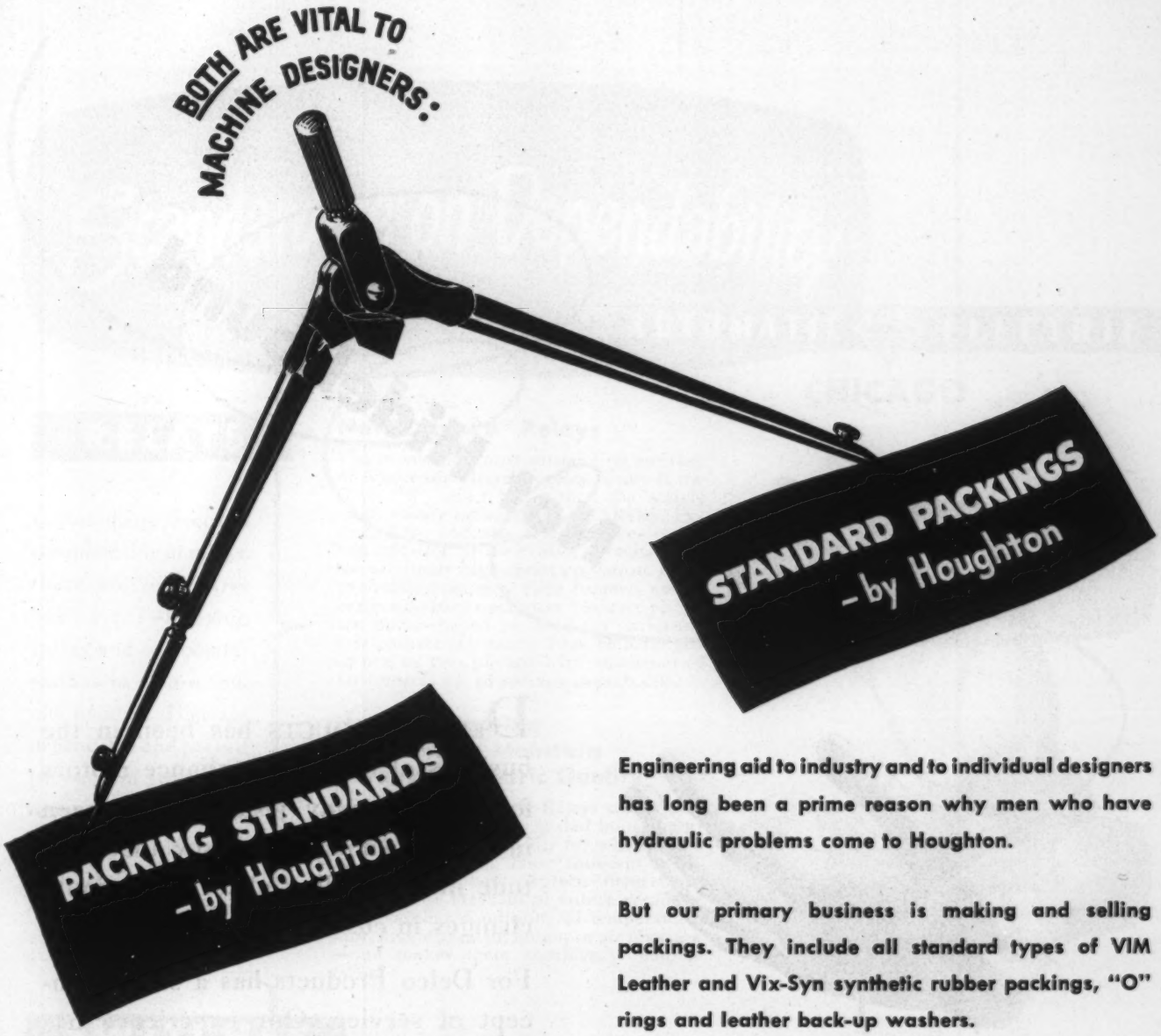
Installation of the Bearings is a simple arbor press operation. Lubrication is greatly simplified, since the turned-in lips of the shell of Needle Bearings retain an ample reserve of lubricant. With wear reduced to a minimum, savings in maintenance may run as high as 20 to 1, according to the manufacturer's experience.

This case shows how the performance, lubrication and service life of *your* equipment can be improved by a simple change to Torrington Needle Bearings. Let our engineers help you adapt them to your needs. Write us today. THE TORRINGTON COMPANY, Torrington, Conn., or South Bend 21, Ind. District offices and distributors in principal cities of United States and Canada.



TORRINGTON NEEDLE BEARINGS

Needle • Spherical Roller • Tapered Roller Straight Roller • Ball • Needle Rollers



Another Houghton "first"—a request to the packing industry from large users, which was promptly met by Houghton, and Houghton alone!

The Joint Industry Conference on packing standards has accepted our engineers' recommendations on how to promote interchangeability of packing sizes, reduce the number and adopt uniform "dash" numbers and coding for users' machine plates.

All of which should indicate that Houghton experience was of definite aid. Have you a copy of the "Packing Standards" free book which explains the whole project? Write for it.

Engineering aid to industry and to individual designers has long been a prime reason why men who have hydraulic problems come to Houghton.

But our primary business is making and selling packings. They include all standard types of VIM Leather and Vix-Syn synthetic rubber packings, "O" rings and leather back-up washers.

May we quote on your production needs, with the assurance that your individual packing problems will be painstakingly handled? E. F. Houghton & Co., Philadelphia 33, and all principal cities.

HOUGHTON'S VIM LEATHER and VIX-SYN PACKINGS

Not Hidebound

DELCO PRODUCTS has been in the business of building appliance motors for a good many years. We've been in it long enough to know that latitude must be allowed for last-minute changes in customers' scheduling.

For Delco Products has a sound concept of service. Our experience has taught us to appreciate the manifold problems a manufacturer runs up against. All our resources are organized to help meet them promptly and smoothly . . . to deliver on time.

It's this human, personal quality as well as our complete, modern engineering and manufacturing facilities that makes Delco Products a byword for the finest in appliance motors.

DELCO PRODUCTS DAYTON, OHIO

DELCO MOTORS

DELCO PRODUCTS

Division of General Motors Corporation, Dayton, Ohio

Sales Offices: **CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HARTFORD, CONN.**

Standardize on Dependability

AUTOMATIC ELECTRIC

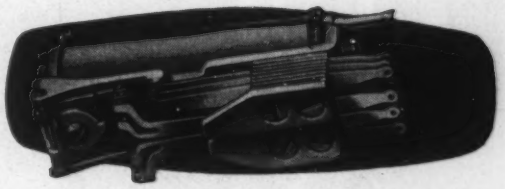
CHICAGO

RELAYS

In Automatic Electric's complete line of relays, there are over forty basic types—offering spring and coil combinations in almost infinite number. They are dependable and proved products of an organization that has made electrical remote control its business for more than fifty years.

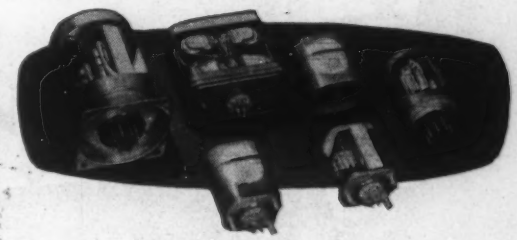
New Class "B" Relays

The newest and most outstanding member of Automatic Electric's relay family is the Class "B"—even better than the widely used, *widely copied* Class "A" Relay. Designed for ordinary relay service—opening, closing or switching circuits—and for extremely high-speed operation. Independently operating twin contacts assure perfect contact operation. Contact points are dome-shaped to maintain uniformly low contact resistance. May be arranged in one or two pileups with maximum of 16 contacts on 13 springs in each pile.



Hermetic Sealing Available To Maintain Automatic Electric Quality

All Automatic Electric Relays can be obtained in hermetically sealed housings to maintain the high quality for which these relays are famed. The "sealed-in" controlled atmosphere protects them from electrical or mechanical failure resulting from varying conditions of temperature, dust, humidity, acid, fungus or air pressure —and makes them completely tamperproof.



SWITCHES

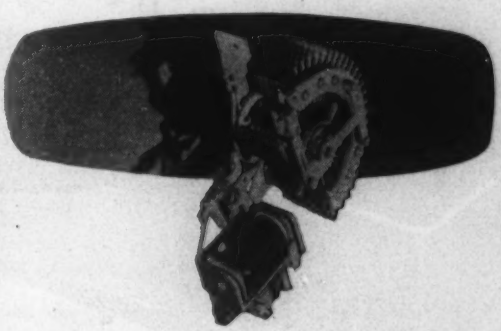
Automatic Electric Stepping Switches are designed and built to assure exceptionally long life. A complete range of Automatic Electric Switches is available for all remote control applications.

The New Type 45 Switch

Here, for example, is a rotary switch that's new and better! *Faster*... 70 steps a second. *Greater capacity* . . . up to 10 (or more) 25-point bank levels, with single-ended wipers available for 50-point operation. *Simpler* . . . only one field adjustment.

Compact rotary and re-set type switches are also available with 10-point bank levels and speeds of 35 steps a second for automatic or remote-control operations.

And there's the famous "Two-Motion Switch" that selects one circuit from among two hundred in just *2 seconds* or less. It's a re-set type switch adaptable to either automatic or remote control.

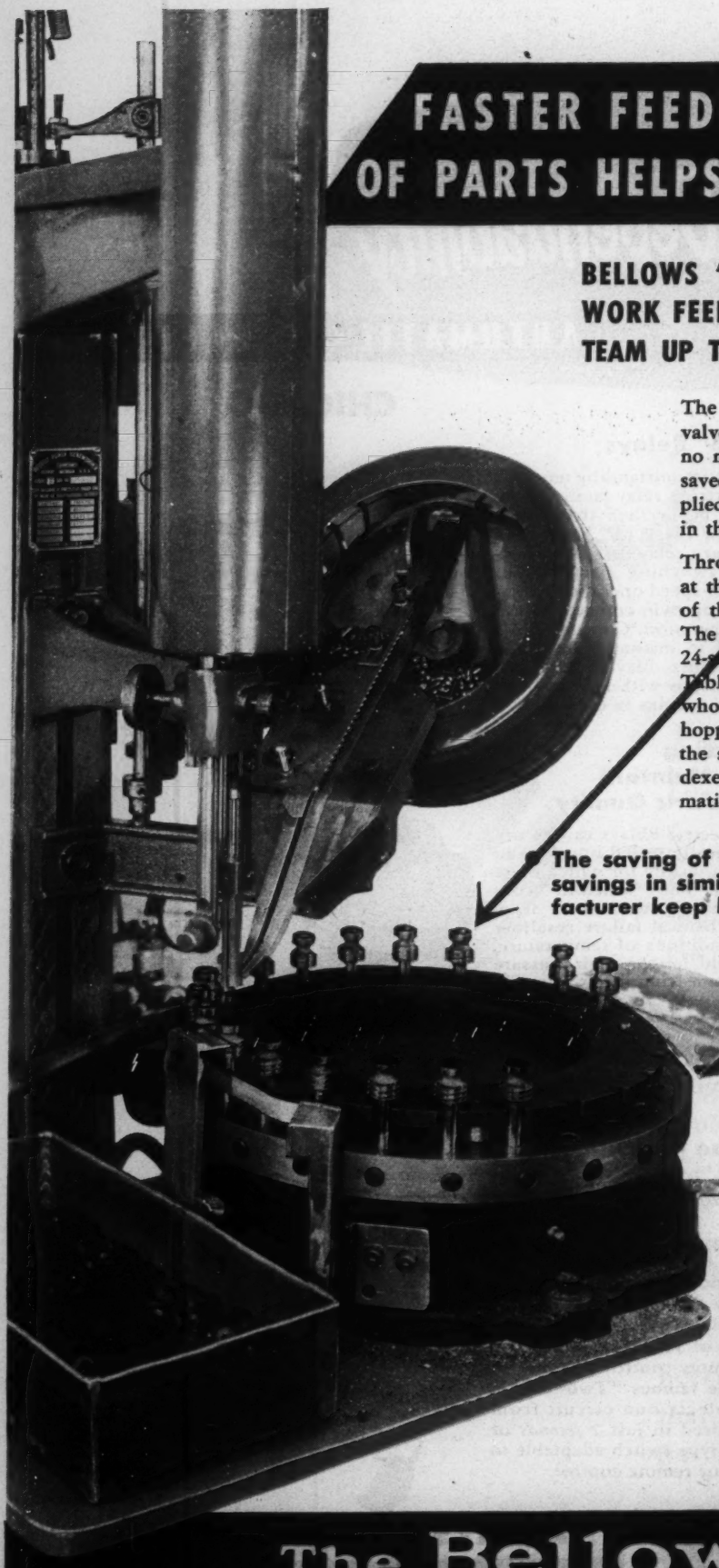


For help in the field of remote control, call in an Automatic Electric field engineer. Meanwhile, send for helpful literature. Address AUTOMATIC ELECTRIC SALES CORPORATION, Chicago 7, Ill. In Canada: Automatic Electric (Canada) Ltd., Toronto.

RELAYS SWITCHES

AUTOMATIC ELECTRIC

CHICAGO



FASTER FEEDING AND EJECTION OF PARTS HELPS CUT COSTS 25%

BELLOWS "CONTROLLED-AIR-POWER" ROTARY WORK FEED TABLE AND BELLOWS AIR MOTORS TEAM UP TO MAKE HAND OPERATION AUTOMATIC

The cost of inserting the washer and screw in the valve stem of a water faucet isn't a major cost item, no matter how it's done. But a fraction of a penny saved here, a fraction of a penny saved there, multiplied by thousands of parts, adds up to major savings in the total cost picture.

Through the ingenious toolroom-built device shown at the left, a mid-western manufacturer cut the cost of this operation 25% under the old method used. The operator loads the valve stem and washer in the 24-station Bellows Rotary Work Feed Table. The Table positions the part under a power screw driver whose spindle is fed by a Bellows Air Motor. The hopper-fed screw is driven to correct pressure, and as the screw driver retracts the Rotary Feed Table indexes to the next position. A third Air Motor automatically ejects the part.

The saving of 25% in this operation, coupled with like savings in similar production processes helps this manufacturer keep his favorable competitive position.

YOU, TOO, CAN CUT PRODUCTION COSTS WITH BELLOWS "CONTROLLED-AIR-POWER"

No matter what you make chances are good [illegible] your plant where Bellows Work [illegible]ds, Bellows Air Motors, Bellows [illegible]ing Devices, and other Bellows "Controlled-Air-Power" Units can help you save important money.

Write for this

FREE BOOK

Or better yet, phone your local Bellows Field Engineer; ask him to bring you a copy of Bulletin CL-15. Let him show you how Bellows "Controlled-Air-Power" Devices are helping others beat the squeeze on profits.

The Bellows Co.

AKRON, OHIO

ATLANTA • BALTIMORE • BIRMINGHAM, MICH. • BOSTON • BROOKLYN • BUFFALO • CANTON • CEDAR RAPIDS, IA. • CHICAGO • CINCINNATI • CLEVELAND
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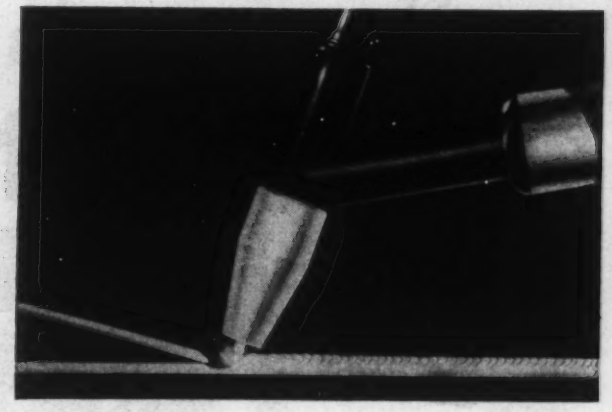
SCHENECTADY, N. Y. • SPRINGFIELD, MASS. • SYRACUSE, N. Y. • TOLEDO, O. • WARSAW, IND. • WEST HAVEN, CONN.

Weld Sheet Steel with the HELIARC torch

Trade-Mark



and wipe out one complete operation

AS WELDED — *This photograph, unretouched and natural size, shows that* HELIARC *welds in sheet steel are clean and uniform.*

There is no spatter or flux, so you save cleaning costs when you switch to the HELIARC process for welding sheet steel. And you keep the advantages of high speed, and minimum distortion that are characteristic of arc welding. Any manual arc or gas welding operator finds welding with a HELIARC torch easy to master.

Porosity-free welds in killed low-carbon steel up to $\frac{1}{8}$ in. thick can be made with this process. In non-killed grades, welds are as nearly gas free as can be produced by any welding process. Argon-shielding prevents pick-up of atmospheric gases. No argon is dissolved in the weld.

Joints welded with the HELIARC torch will not show under paint, lacquer, or even vitreous enamel finish. It takes only a light grinding to remove the low, smooth ripple and make the bead flush with the surface.

Get more information on this fast, clean, welding process from any LINDE office. Let us show you how it can improve your product and cut your costs. Just fill in the coupon.

The terms "Linde" and "Heliarc" are registered trade-marks of The Linde Air Products Company.

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street New York 17, N. Y.
Offices in Other Principal Cities
In Canada:
DOMINION OXYGEN COMPANY, LIMITED, Toronto

THE LINDE AIR PRODUCTS COMPANY
30 East 42nd Street, New York 17, N. Y.
(or your nearest LINDE office)

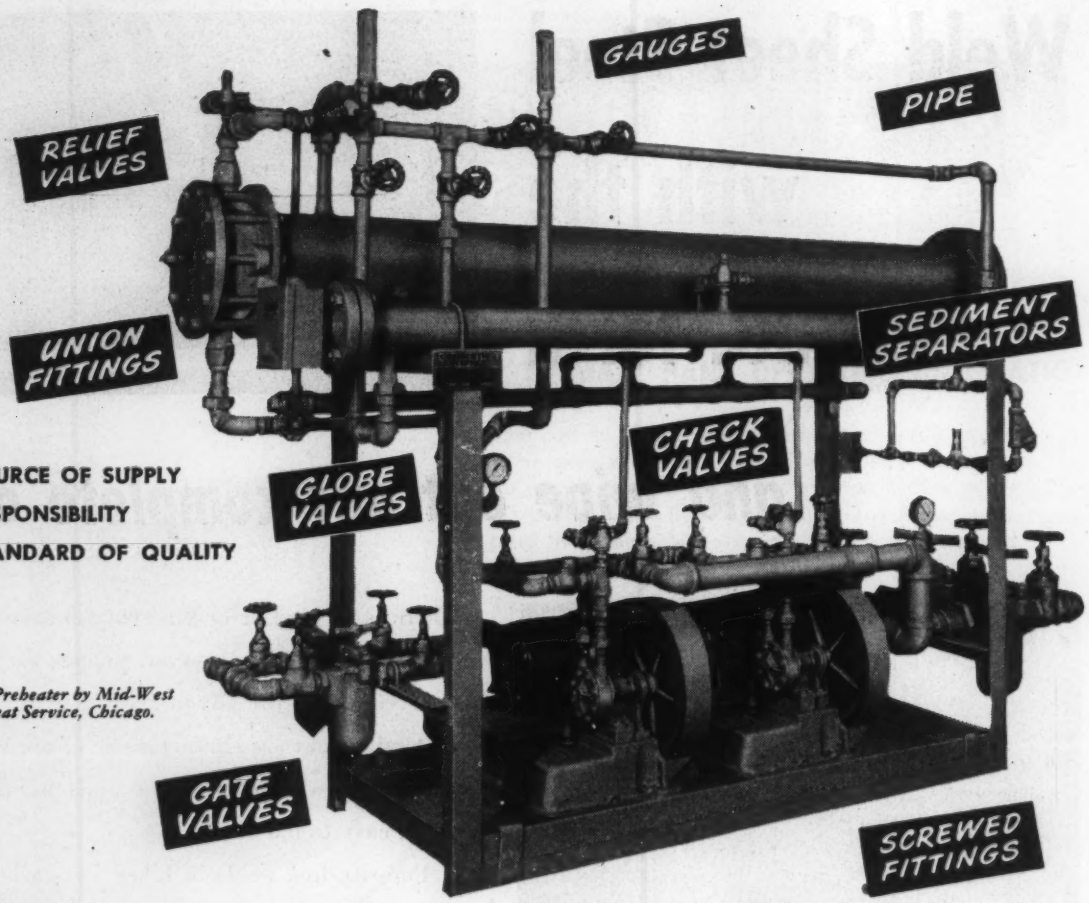
Gentlemen: We would like more information on welding sheet steel with the HELIARC torch. We manufacture ..... (Product) from ..... (Metal) of ..... (Thickness)

We are ☐ (are not ☐) now using inert gas-shielded welding

Name..... Position.....

Company.....

City..... State.....



ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

Oil Preheater by Mid-West Heat Service, Chicago.

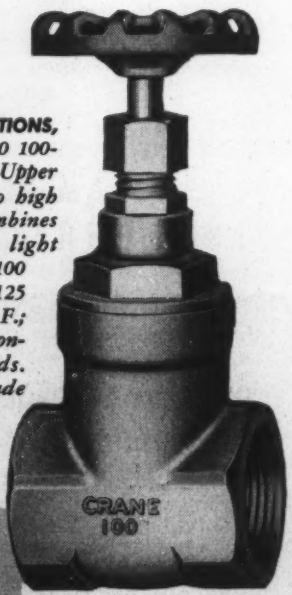
Everything in piping for every design ... from one complete line

Take an Oil Preheater, for example. In this case, Crane equipment controls the flow of steam and heated fuel oil. But regardless of fluids ... or product design ... you get what you need when you specify Crane. One catalog gives you easy access to the world's most comprehensive selection of valves, fittings, pipe and accessories ... in brass, iron, steel and alloy materials.

You can depend on the unequalled completeness of this **Single Source of Supply** to both speed and simplify every piping procedure. **One Responsibility** for materials helps to assure better control of assembly operations; makes for simplified buying and storekeeping. And don't overlook the added value Crane equipment gives to any product design. For your customers know from experience that **High Quality** and Crane Quality are synonymous.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

FOR LOW PRESSURE APPLICATIONS, *Crane recommends No. 410 100-pound brass gate valves. Upper body—similar in design to high pressure steel valves—combines maximum strength with light weight. Working pressures: 100 pounds saturated steam; 125 pounds water of 200 deg. F.; 125 pounds cold oil or gas. Non-rising stem; screwed ends. Sizes: ¼ to 2 in. Also made with solder-joint ends (No. 1320), in sizes ⅜ to 2 in. Write for folder AD-1725.*



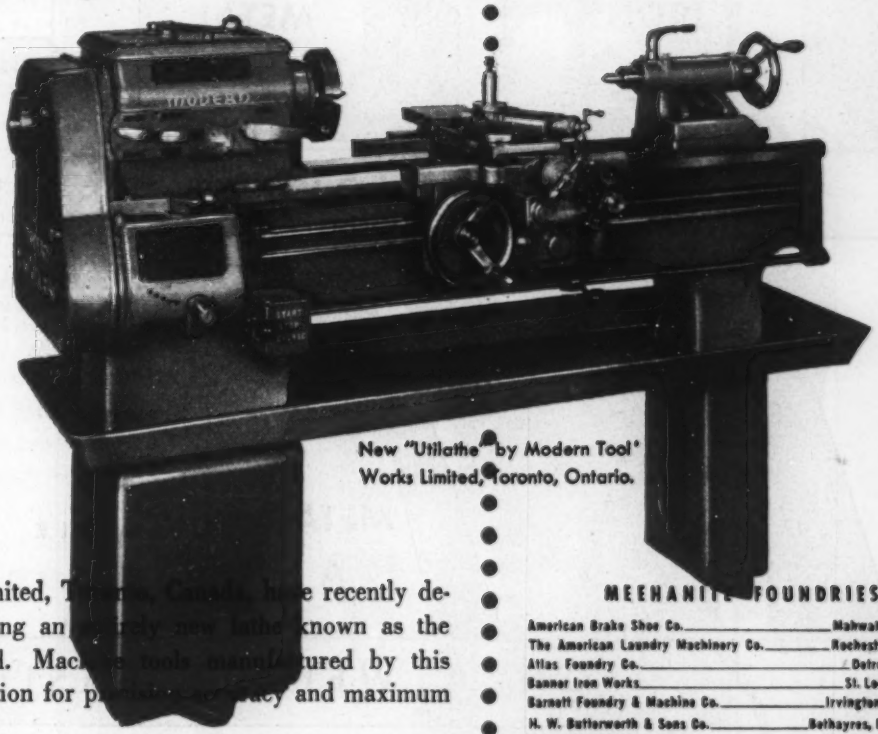
EVERYTHING FROM ...

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

Machine Tool Precision Requires MEEHANITE® *Properties and Quality*



New "Utilathe" by Modern Tool Works Limited, Toronto, Ontario.

THE Modern Tools Works Limited, T..., Canada, h... recently designed and are now producing an ... new lathe known as the MODERN "Utilathe", illustrated. Mac... tools manufactured by this company have acquired a reputation for p... accuracy and maximum performance in production.

From its inception this machine was designed to take full advantage of those engineering properties of Meehanite castings which would contribute to its quality, such as good strength characteristics, maximum vibration absorption, dimensional stability, uniform solidity and good machinability. These castings include:

1. Bed
2. Carriage
3. Cross Slide
4. Compound Slide
5. Headstock
6. Tailstock

Designers of this equipment, like those of many other machine tools "design with confidence" based on their sure knowledge that Meehanite castings over the years provide, regularly and repeatedly, known and established engineering characteristics. Builders of today's equipment rightfully demand this assurance of dependability.

Your product—your new design, can benefit similarly.

For further information write for the Handbook of Meehanite Metals to any of the foundries listed.

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
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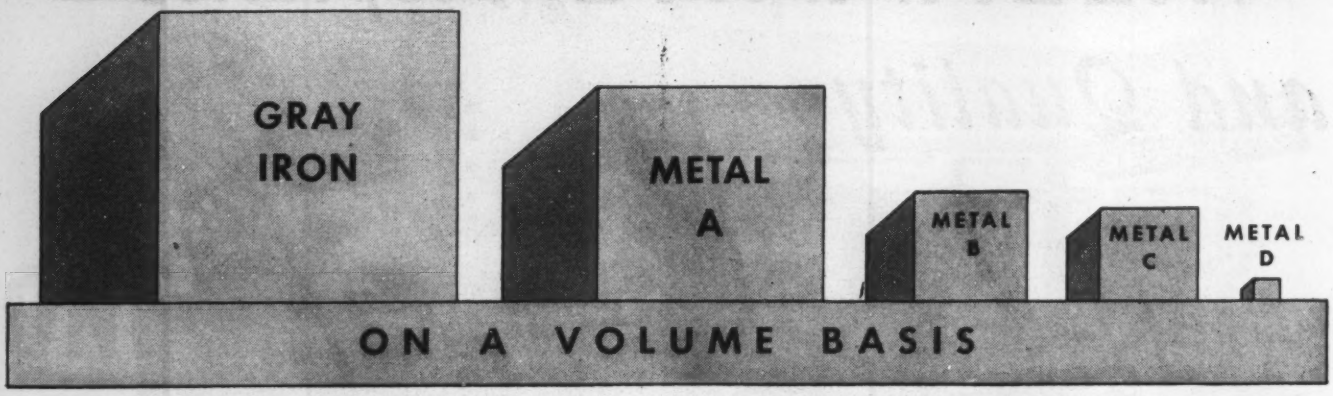
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Smith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
U. S. Challenge Co.	Centerville, Iowa
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

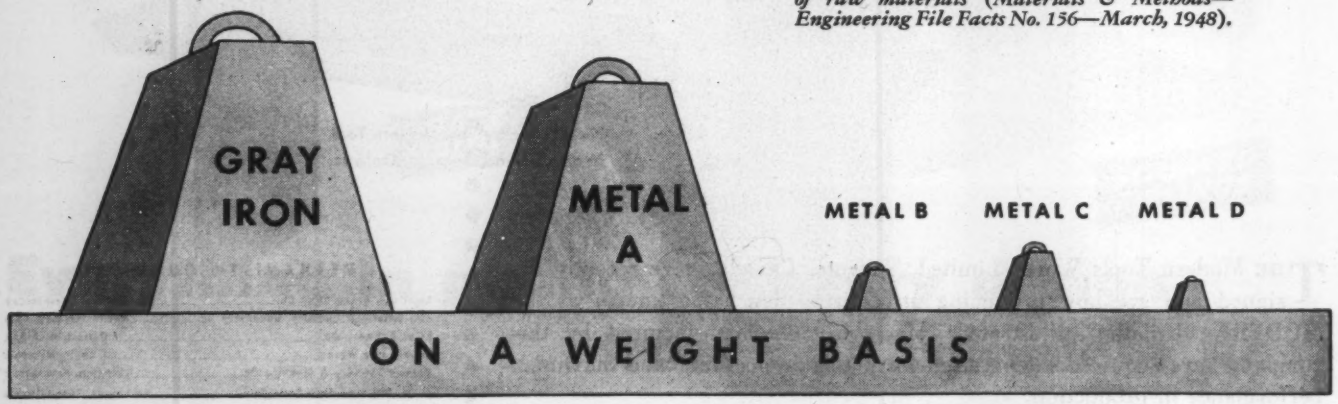
"This advertisement sponsored by foundries listed above."

NEW ROCHELLE, N. Y.

How much metal can you buy for $1



Comparisons in these charts based on the costs of raw materials (Materials & Methods—Engineering File Facts No. 156—March, 1948).



Whether by Volume or by Weight
GRAY IRON is your BEST BUY

For stability and rigidity, there are no substitutes for volume and weight.

So if you need stability and strength in your products, Gray Iron offers you the greatest ultimate economy.

Add to this Gray Iron's other characteristics . . . *castability, rigidity, low notch sensitivity, wear resistance, heat resistance, corrosion resistance, machinability, vibration absorption, durability, wide strength range* . . . and you have an unmatched combination of advantages.

Write Department "E" for free booklet, "GRAY IRON—Its Mechanical and Engineering Characteristics, and Details for Designing Cast Components".

Make It Better with Gray Iron

Second Largest Industry in the Metal-Working Field

GRAY IRON FOUNDERS' SOCIETY, INC.

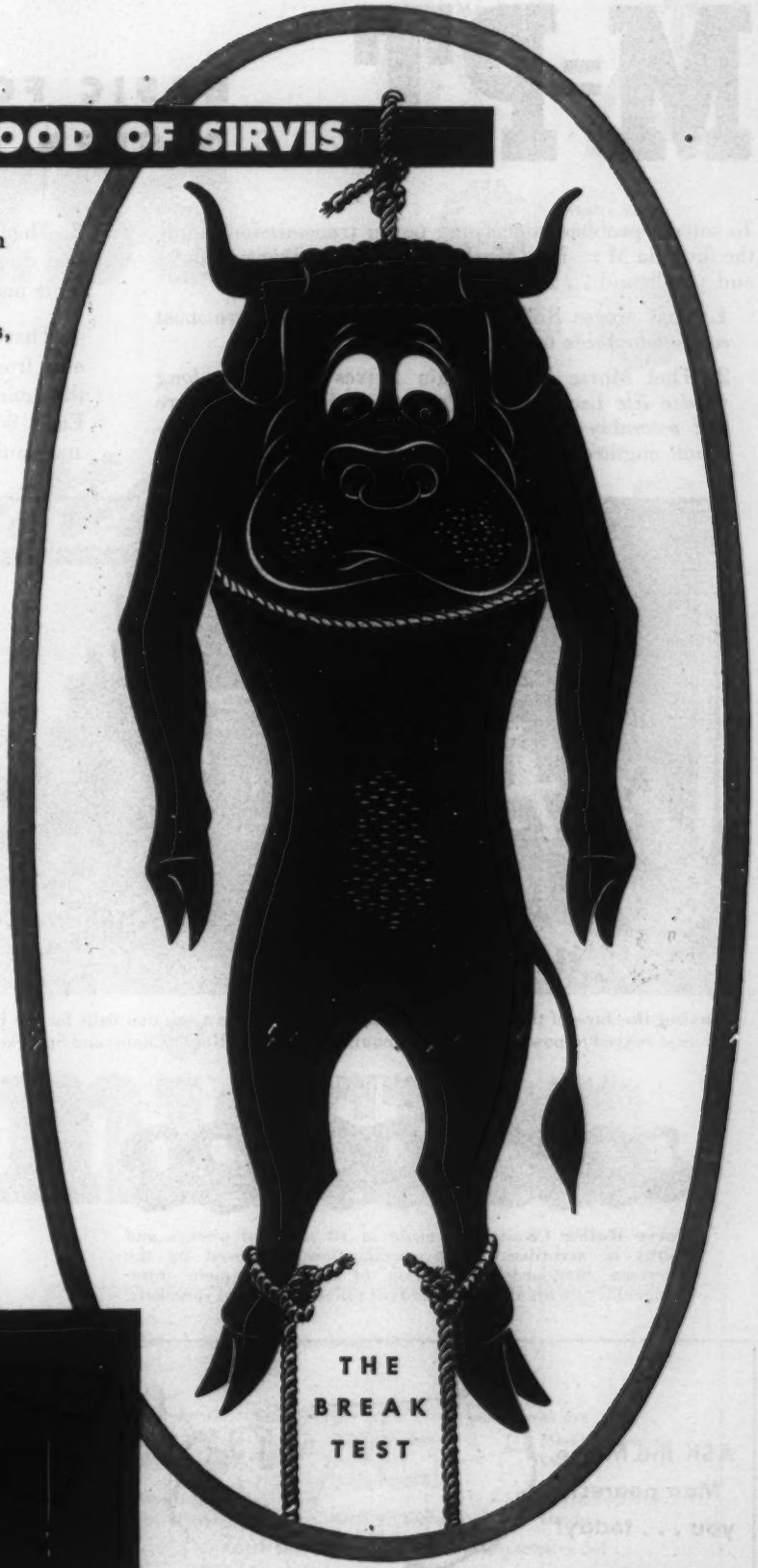
NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

IT'S ALL FOR THE GOOD OF SIRVIS

Stretching steers is out of our line. But, in testing Sirvis' tensile strength, steer*hide* is stretched until it breaks. Because Sirvis leather varies with tannage and treatments, each hide is given the break test to determine its suitability for varying applications. For example: a sample of steerhide being considered for transmission oil seals will be soaked in an "E. P." lubricant. The break test will then indicate the effects of this type of oil upon tensile strength. If the percentage of breakdown is well within the limits established for Sirvis oil seal leathers, the hide is certified for use. Similar immersion and break tests are conducted to determine the action of hot oil, water, salt solutions, and the many other liquids with which Sirvis leather parts must come in contact. In each case, the break test indicates the limits within which a given piece of hide can be used.

This is just one of the many laboratory-controlled tests to which Sirvis leathers are subjected . . . so that you may be assured of top quality in *packings, boots, gaskets, diaphragms and other mechanical leather products.* Because of extreme care in designing, excellence of materials, and constant checks in production, Sirvis mechanical leathers are outstanding in dependability.

• *For detailed information about Sirvis products, write for the free Chicago Rawhide catalog.*



OTHER C/R PRODUCTS
PERFECT OIL SEALS
SIRVENE SYNTHETIC RUBBER

MECHANICAL LEATHER PRODUCTS **sirvis**

CHICAGO RAWHIDE MANUFACTURING COMPANY

1304 Elston Ave., Chicago 22, Illinois

New York • Philadelphia • Detroit • San Francisco • Cleveland • Boston
Pittsburgh • Los Angeles • Cincinnati • Minneapolis • Syracuse • Peoria

M=PT . . . BASIC FORMULA FOR . . . DESIGN ENGINEERS

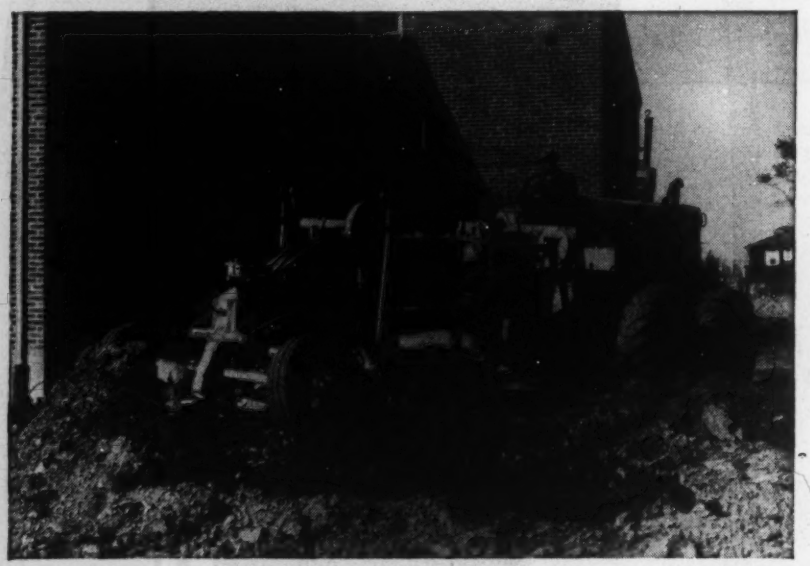
To solve a problem concerning power transmission, apply the formula M = PT (Morse means Power Transmission) and you'll find . . .

1. That Morse Roller Chains and Sprockets are most *easily adaptable* to your specific design needs.

2. That Morse Roller Chain Drives have *extra-long service life* because every phase of their manufacture and assembly is under rigid quality control and precision engineering supervision.

3. That Morse Roller Chain maintenance is *extremely low* due to the use of the finest quality materials in their manufacture.

4. That Morse Roller Chain Drives are *quickly obtainable* from shelf stock. *Ask the Morse Man* from any of the hundred Morse Branch Offices and Distributors. Each is staffed with engineers experienced in every mechanical power-transmission application.



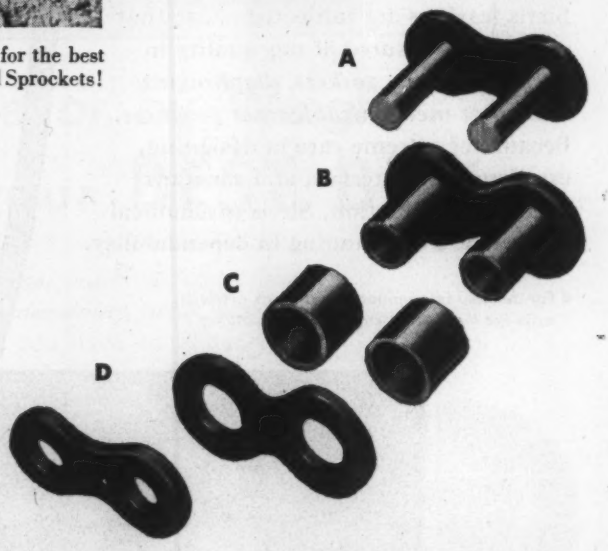
Shaving the face of the earth with a Gargantuan blade is a job that calls for the best and most rugged in power transmission equipment—Morse Roller Chains and Sprockets!

Why Morse Roller Chain Drives Are Specified For The World's Toughest Jobs

For the world's biggest and toughest earth-moving jobs, many road graders and 'dozers now use Morse Roller Chains to transmit power to forward and rear drive wheels. Precision-made, positive-acting Morse Roller Chain Drives are the design engineer's favorite method of transmitting power where *dependability* and long, rugged *service life* come first! When your design calls for roller chain . . . call the nearest Morse Man!

Morse Roller Chains are made in all standard pitches and widths in accordance with specifications approved by the American Standards Association to assure complete interchangeability with all other standard roller chains and sprockets.

Exploded View of Morse Roller Chain Shows Why It's Specified By Design Engineers



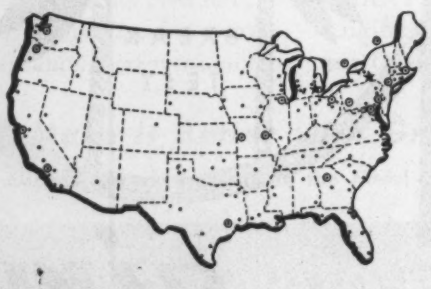
A Morse Roller Chain pins are made from special, high-nickel, fine-grain alloy steel. They are heat-treated and finished for extra strength and extreme resistance to wear.

B Bushings are curled from high-quality alloy steel to give the smoothest possible O.D. and I.D. Smooth inner surface and true roundness eliminates scoring of pins and results in longer life. Bushings are case-hardened.

C Rollers are heat-treated for toughness to provide maximum strength and the greatest possible resilience to shock.

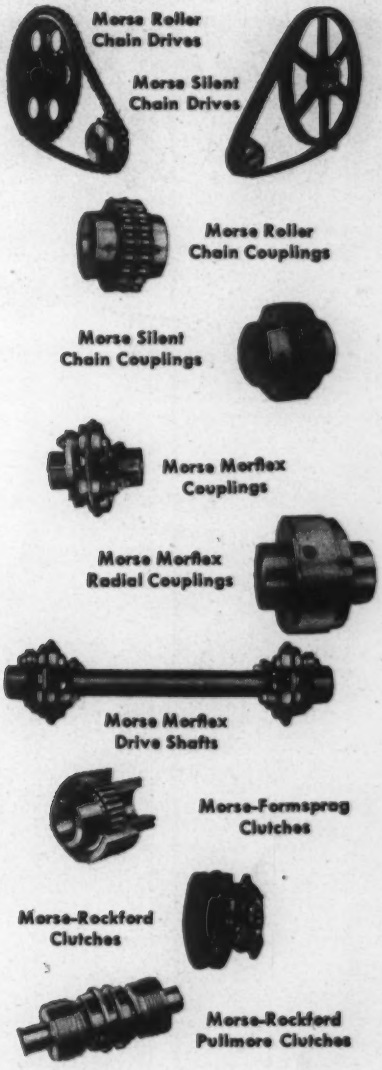
D Plates are heat-treated for structural strength and endurance. Apertures are accurately pierced and sized to provide rigid retention of pins and bushings through proper press fits.

ASK the Morse Man nearest you . . . today!



From coast to coast there are more than 100 offices, representatives and distributors of Morse Power Transmission products to give you quick information and service when you want it—where you want it. *Ask the Morse Man first in any case!* Check your classified phone directory under "Power Transmission" or "Chains."

Morse *means* Power Transmission



MORSE

MECHANICAL POWER TRANSMISSION PRODUCTS

PRODUCTS OF B-W BORG-WARNER

Morse Chain Company
7601 Central Avenue, Dept. 454
Detroit 8, Michigan

Gentlemen:

Please send me latest technical data and specifications on:

- ☐ Roller Chains and Sprockets
- ☐ Morse Silent and Roller Chain Couplings
- ☐ Morse-Formsprag Clutches
- ☐ Silent Chains and Sprockets
- ☐ Morflex Couplings
- ☐ Morse-Rockford Clutches
- ☐ Pullmore Clutches
- ☐ Have representative call

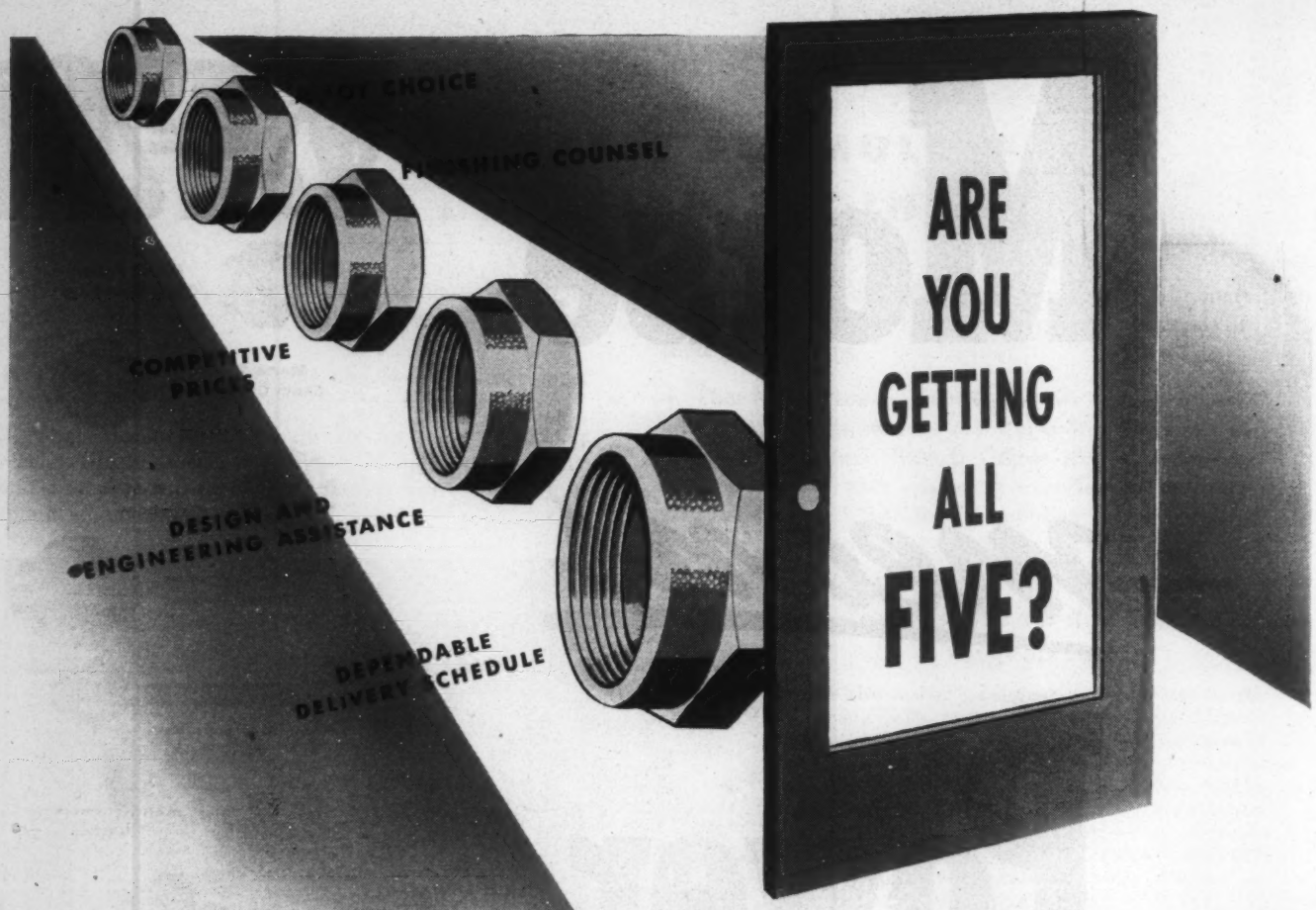
Name_____

Title_____

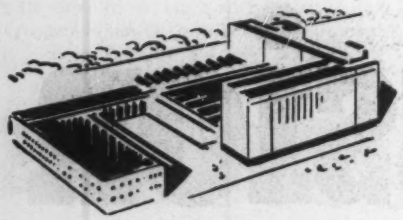
Company_____

Address_____

City_____ Zone____ State_____



Buy screw machine parts from Alcoa— the men who know the metal best



Complete facilities under one roof

Alcoa Aluminum screw machine parts give you strength with light weight, close tolerances where required, added sales appeal for your product.

Aluminum screw machine parts made *by Alcoa* give you even more: the know-how of the organization that pioneered aluminum in automatic screw machines; aluminum-trained experts who offer engineering, alloy choice and finish selection counsel —at no added cost to you.

You get all these plus competitive prices and dependable delivery.

Your Alcoa sales representative will be glad to give you complete information on our capacity, and a prompt quotation. Or write ALUMINUM COMPANY OF AMERICA, 676L Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA

ALCOA ALUMINUM SCREW MACHINE PRODUCTS

INGOT • SHEET & PLATE • SHAPES, ROLLED & EXTRUDED • WIRE • ROD • BAR • TUBING • PIPE • SAND, DIE & PERMANENT MOLD CASTINGS • FORGINGS • IMPACT EXTRUSIONS
ELECTRICAL CONDUCTORS • SCREW MACHINE PRODUCTS • FABRICATED PRODUCTS • FASTENERS • FOIL • ALUMINUM PIGMENTS • MAGNESIUM PRODUCTS

Wichita City Library

Further Information?

IF YOU DESIRE MORE INFORMATION ON ANY ADVERTISEMENT IN THIS ISSUE

Here's What You Do:

Write the name of the advertiser and the page number of the ad in the spaces provided on the card. Check the type of information you want — whether it has to do with price, where you can buy it, or more needed details—or all three, if you wish. After you have finished going through MACHINE DESIGN and have jotted down all the ads on which you'd like more information, just tear off the card and drop it in the mail. No postage is required. We'll have our staff forward this information immediately to the advertiser, so that you will be relieved of the necessity of writing a number of letters. You will then hear directly from the advertiser, answering your request. Because we know that MACHINE DESIGN gets around, and that more than one person sees your copy, we have made up three cards so that if you are one of the later readers, you can still have the opportunity of taking advantage of this service.

Please send further information on the following advertisements in this issue:

PAGE NO.	NAME OF ADVERTISER	Send Technical Data	Send Price Information	Nearest Source of Supply
		○	○	○
		○	○	○
		○	○	○
		○	○	○
		○	○	○

YOUR NAME _____ TITLE _____

COMPANY _____

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IF YOU DESIRE MORE INFORMATION ON ANY ADVERTISEMENT IN THIS ISSUE

Here's What You Do:

Write the name of the advertiser and the page number of the ad in the spaces provided on the card. Check the type of information you want — whether it has to do with price, where you can buy it, or more needed details—or all three, if you wish. After you have finished going through MACHINE DESIGN and have jotted down all the ads on which you'd like more information, just tear off the card and drop it in the mail. No postage is required. We'll have our staff forward this information immediately to the advertiser, so that you will be relieved of the necessity of writing a number of letters. You will then hear directly from the advertiser, answering your request. Because we know that MACHINE DESIGN gets around, and that more than one person sees your copy, we have made up three cards so that if you are one of the later readers, you can still have the opportunity of taking advantage of this service.

They can't stand Spots before their eyes!

For Every Bearing

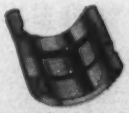
No, the people in our Quality Control Group can't stand even *one* spot before their eyes, when it comes to okaying a bearing, because they are passing on one of the most precise parts that goes into an engine assembly.

In the case of the plain copper-lead main bearing shown above, this okay must be given 87 times. On more complex items—such as flanged bearings—an even greater number of tests is necessary.

These manufacturing controls pay off for you! They are your assurance of high quality and exact adherence to your specifications. You get maximum performance when you use Federal-Mogul *silent* sleeve bearings. Consult our engineers on your requirements.

HIGH SPEED, high temperature, automotive type bearings available in many combinations.

SPEED & LOAD bearings for pumps, compressors, industrial electric motors and similar uses.



HEAVY LOAD for big Diesels, power plants, etc.—bearings up to 27½" O.D., steel and bronze back.

BRONZE PARTS in many shapes, sizes; thrust washers, bushings; for many types of applications.

1899 • Fifty Years of Continuous Bearing Experience • 1949

FEDERAL-MOGUL

FEDERAL-MOGUL CORPORATION

FEDERAL Mogul Silent SLEEVE BEARINGS

11045 SHOEMAKER, DETROIT 13, MICH.

with WHITNEY Roller Chain Drives

Delivery constant, full power from driver to driver mechanisms . . . that's one of the major advantages of using chain drives.

Deeply seated in the sprocket, Whitney Roller Chain eliminates power loss because there is no slippage or friction loss. This means that full rated horsepower is delivered . . . constant speed maintained . . . highest transmission efficiency always obtained.

In addition, Whitney Chain absorbs shock loads without breakage, assuring long operating life; while the flexibility and adaptability of chain drives simplifies design problems.

For positive power transmission specify and use Whitney Roller Chain . . . the *all steel drive*. Write for information.

CHAIN DRIVE IS BETTER

- Positive Grip
- Transmission of full horsepower
- High resistance to shock loads
- High load carrying capacity
- Simplifying transmission designs
- Low Maintenance
- Ease of installation
- Long operating life
- Constant uniform speeds

WHITNEY

WHITNEY CHAIN & MFG. CO.
Division of
Whitney-Hanson Industries Inc.
205 Hamilton St.,
Hartford 2, Conn.

Roughing cuts or precise finishing— TIMKEN® bearings help handle both

THIS Monarch 25″ Model N engine lathe is used for both heavy roughing cuts and precise finishing. With Timken tapered roller bearings throughout the headstock, spindle accuracy is assured. And, because of their tremendous load carrying capacity, Timken bearings take the shock of roughing cuts easily.

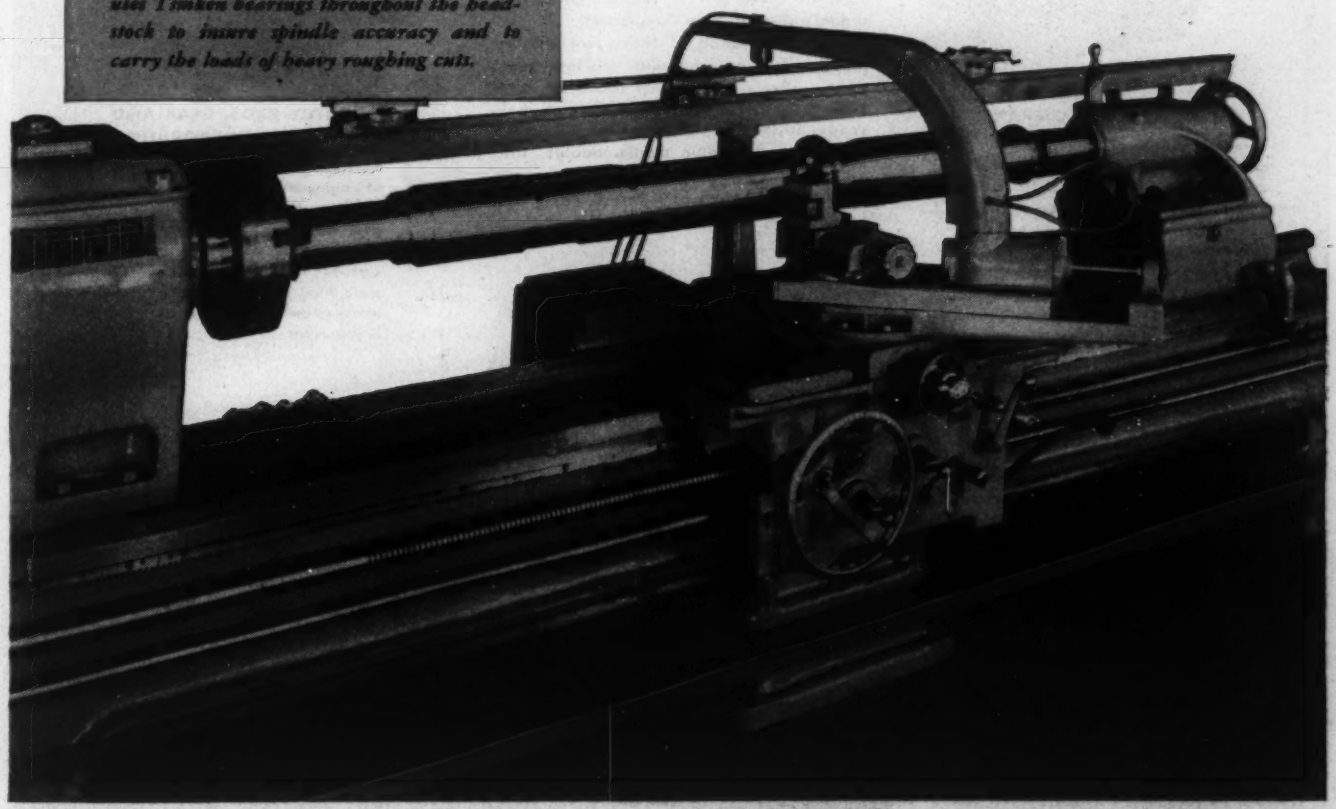
The tapered construction of Timken roller bearings carries tremendous thrust as well as radial loads without deflection or endmovement and permits preloading to any desired degree.

Timken bearings are manufactured to extreme precision and finished to incredible smoothness. The rolls and races are made of Timken fine alloy steel for toughness and case-hardened for exceptional resistance to wear. The line contact between rolls and races provides maximum load-carrying capacity.

No other bearings can give you *all* the advantages you get in Timken tapered roller bearings. Make sure you have Timken bearings in all the machines you build or buy. Look for the trade-mark "Timken" on the bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

THE MONARCH MACHINE TOOL COMPANY *uses Timken bearings throughout the headstock to insure spindle accuracy and to carry the loads of heavy roughing cuts.*



NEW TIMKEN BEARING CUTS RUN-OUT IN HALF!

Until now, the Timken "Zero" bearing has been the last word in bearing accuracy. Now Timken offers industry the "Double-Zero" bearing—*twice as accurate* as the "Zero"! Maximum run-out of the new "Double-Zero" bearing is only 75 millionths of an inch—*half* the 150 millionths run-out of the "Zero" bearing.

What an opportunity for manufacturers of machines where extreme accuracy is essential! Available in standard single row types, up to 10″ O. D. Write for further information.

TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

TIMKEN 1899 50 1949 YEARS

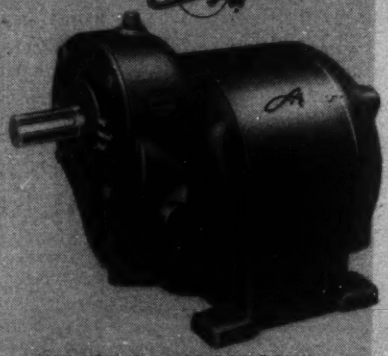
NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

Two Leaders of Industry

COMBINE SKILLS AND PRESENT

the FOOTE BROS.—LOUIS ALLIS GEARMOTOR

LOUIS ALLIS



THE LOUIS ALLIS COMPANY

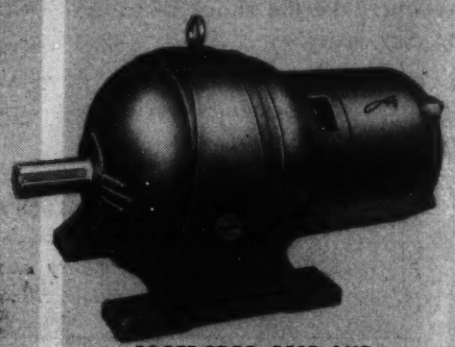
Three generations of designing and building special motors for special applications by THE LOUIS ALLIS COMPANY—plus the creating, developing, and pioneering of many special types of motors for special operating conditions—give you one of—if not THE largest selection of sizes and types of standard and special motors in the entire industry today.

The specialized engineering and manufacturing experience and facilities of FOOTE BROS. GEAR AND MACHINE CORPORATION and THE LOUIS ALLIS COMPANY are now available to industry through the separate sales, service, and manufacturing organizations of both Companies.

The combination of these two quality products into one compact, efficient gearmotor reflects the earnest desire of both firms to better serve industry through their combined skills.

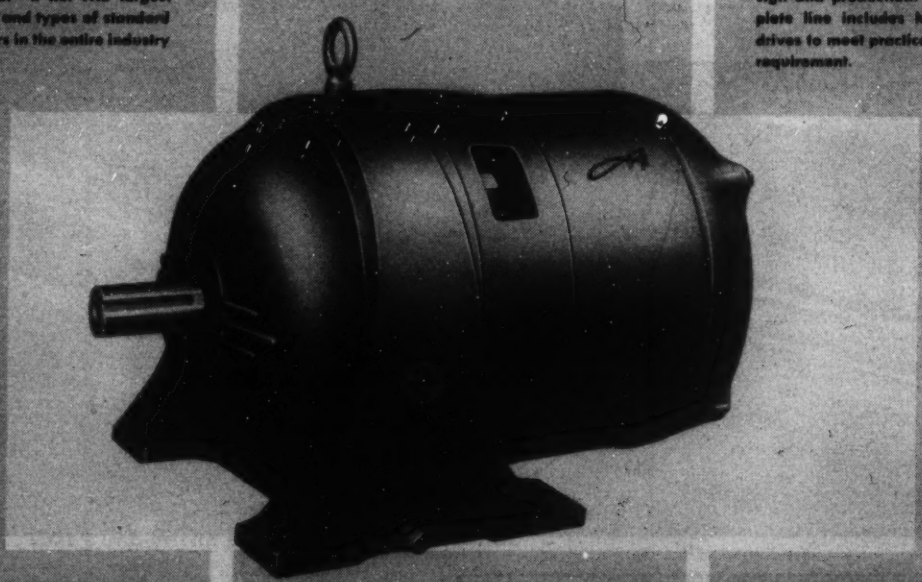
To be available in single, double, and triple reduction in ratings of 1 h.p. through 75 h.p. with open drip-proof, enclosed, splashproof, and explosion-proof motors.

FOOTE BROS.



FOOTE BROS. GEAR AND MACHINE CORPORATION

Back of Foote Bros. is nearly a century of engineering knowledge and manufacturing experience plus the latest in gear generating equipment, all of which assure the highest quality in gear design and production. Foote Bros. complete line includes helical and worm drives to meet practically any industrial requirement.



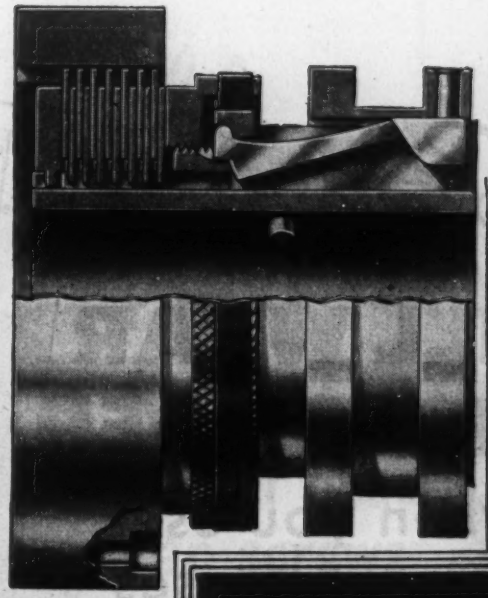
On your very next gearmotor application Specify Foote Bros.-Louis Allis Gearmotors

THE LOUIS ALLIS COMPANY
427 East Stewart Street
MILWAUKEE 7, WISCONSIN

For quick, dependable service—contact nearest Louis Allis or Foote Bros. Gear and Machine Corporation sales office—or write to the home office of either company.

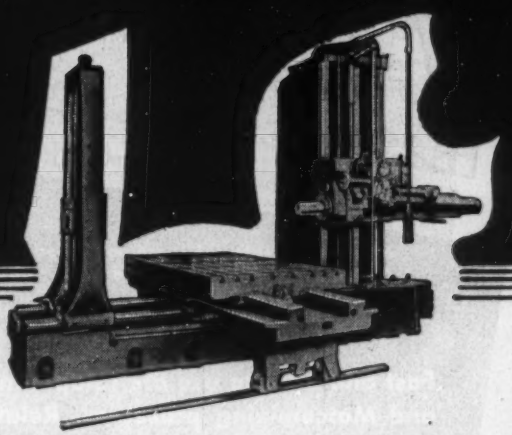
FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard
CHICAGO 9, ILLINOIS

FOR COPY OF GEARMOTOR BULLETIN WRITE TO EITHER COMPANY



MAXITORQ

KEEPS GOOD COMPANY



We continue our "Good Company" series this month with the permission of Giddings & Lewis Machine Tool Company who have adopted the Maxitorq Floating Disc Clutch for their No. 351-T Table Type Horizontal Boring, Drilling and Milling Machine. A single, wet plate Maxitorq controls the power transmission in the feed and rapid traverse unit.

Maxitorq features that win approval from builders of machine tools, machinery and a wide variety of motorized products include: compact design; Separator Springs that keep discs apart to prevent drag, abrasion and heating in neutral; assembly, adjustment and take-apart without tools; and complete assembly shipments so that clutch is ready to slip onto a shaft.

Maxitorq engineers will give you specific and practical recommendations for smooth, dependable power transmission.

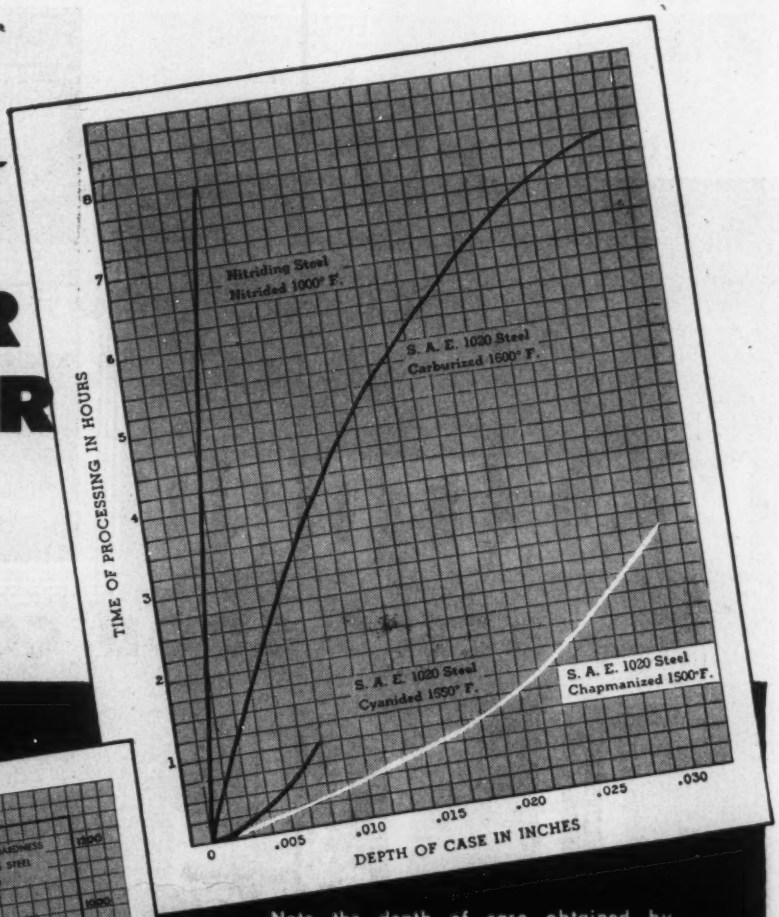
Send for Catalog MD11

8CJ48

THE CARLYLE JOHNSON MACHINE COMPANY

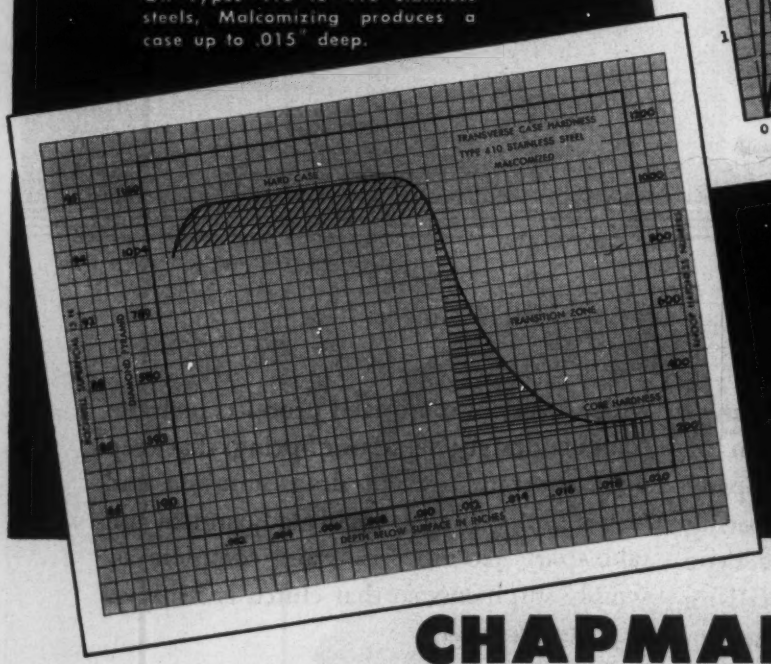
MANCHESTER • CONNECTICUT

Steel parts
WILL WEAR FAR LONGER
when you use these processes



Note the depth of case obtained by Chapmanizing as compared with other processes.

On Types 410 to 416 stainless steels, Malcomizing produces a case up to .015" deep.



Fast and easy to use are Chapmanizing and Malcomizing processes. Relatively inexpensive, too — the answer to the need for greatly increased wear resistance of parts or products at a reasonable cost.

CHAPMANIZING

. . . will give you a .002" to .035" case on low carbon steels in only 1 to 4 hours. You'll find it tough and ductile — always free from chipping or checking. The surface will be silver-clean so that finish grinding is minimized.

MALCOMIZING

. . . will give you the same type of tough case on stainless steels. Average hardness will be 1000 Vickers. And the case will range in depth from .005" to .015" depending on the steel. You'll have no trouble with finish grinding or lapping for maximum hardness is slightly below the surface . . . and the corrosion-resistant qualities of the stainless steel will not be materially affected.

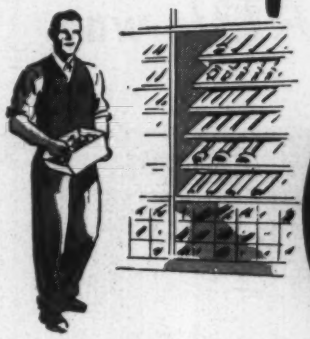
We'd like to tell you the complete story of these processes. Why not write — today.

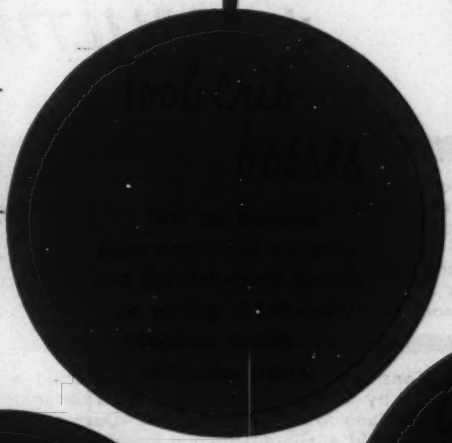
Metallurgical Sales Division of

THE CHAPMAN VALVE MFG. CO.

INDIAN ORCHARD, MASSACHUSETTS

Everybody's sold on PARKER-KALON SIZE-MARKED socket head cap screws





with GEAR-GRIP -fingers won't slip*

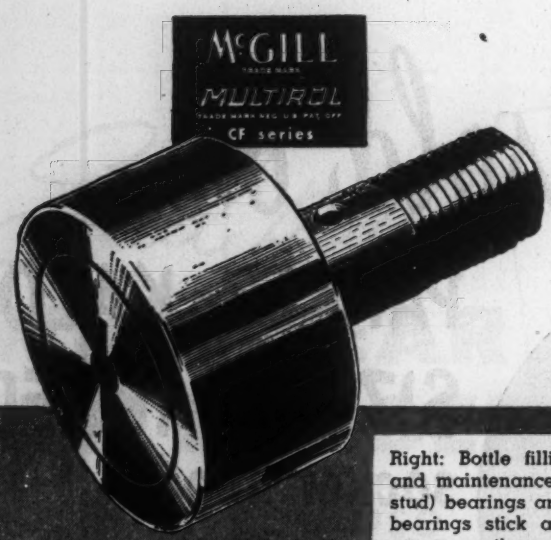
Parker-Kalon Gear Grip prevents fingers from slipping even when oily. Makes fast fingers *sure* fingers.

ONLY ON PARKER-KALON Socket Screws will you find the Size-Mark and Gear Grip . . . developed after extensive study of shop practice to speed work. Samples Free, on request. See why P-K "years ahead" Socket Screws can put your product out front, assembly-wise as well as sales-wise. Send for Stock List Now. Parker-Kalon Corporation, 200 Varick Street, New York 14, N. Y.

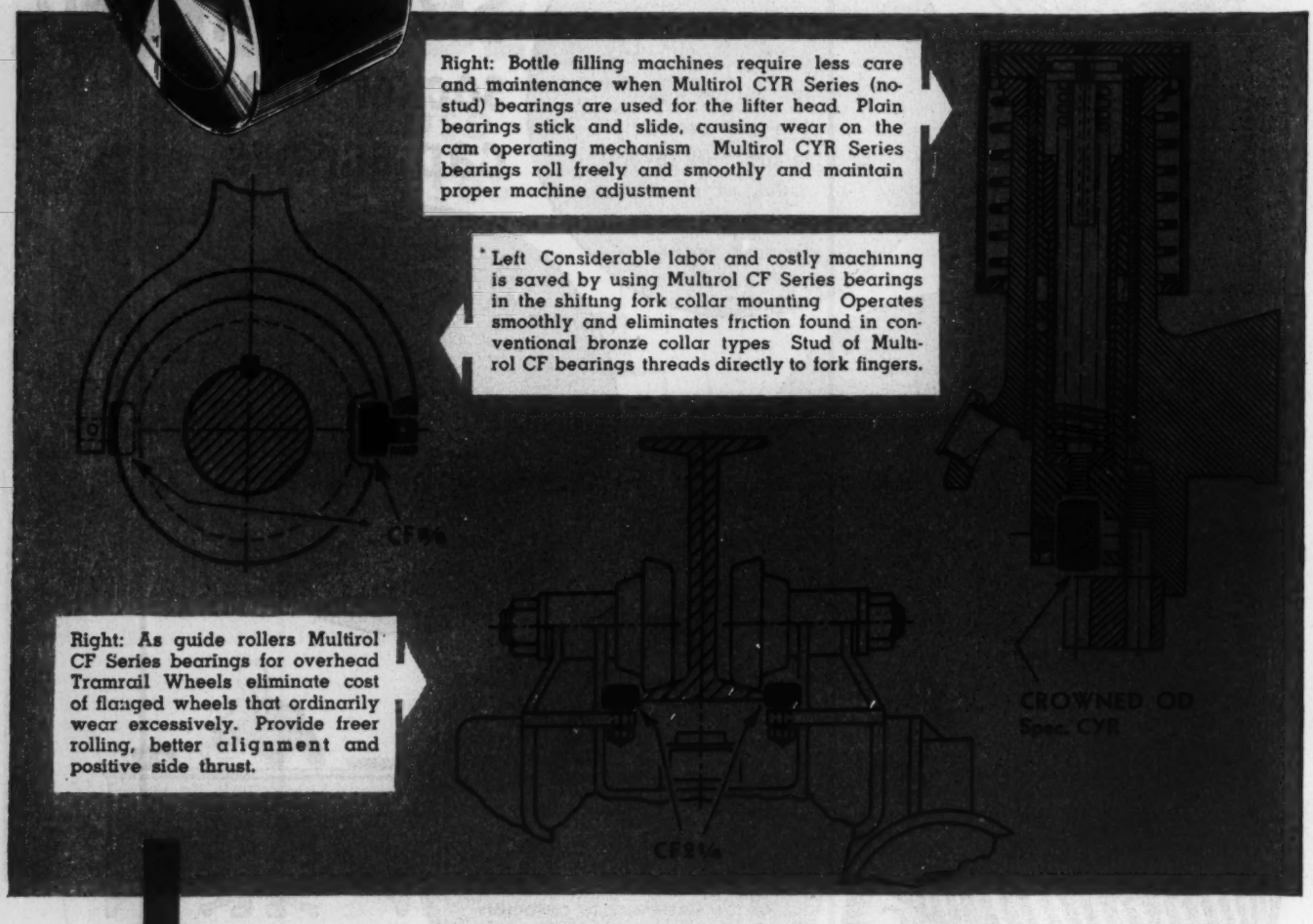
®**PARKER KALON** *cold forged* **SOCKET SCREWS**

AVAILABLE THROUGH ACCREDITED DISTRIBUTORS IN EVERY INDUSTRIAL AREA

*U.S. DESIGN PAT. NO. 126,409



HOW TO ANTI-FRICTIONIZE WITH CAM FOLLOWERS the MULTIROL way


Right: Bottle filling machines require less care and maintenance when Multirol CYR Series (no-stud) bearings are used for the lifter head. Plain bearings stick and slide, causing wear on the cam operating mechanism Multirol CYR Series bearings roll freely and smoothly and maintain proper machine adjustment

Left Considerable labor and costly machining is saved by using Multirol CF Series bearings in the shifting fork collar mounting Operates smoothly and eliminates friction found in conventional bronze collar types Stud of Multirol CF bearings threads directly to fork fingers.

Right: As guide rollers Multirol CF Series bearings for overhead Tramrail Wheels eliminate cost of flanged wheels that ordinarily wear excessively. Provide freer rolling, better alignment and positive side thrust.

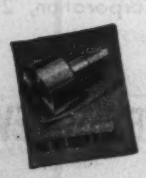
Increased speeds, greater accuracy and all around anti-friction efficiency in guide and support roller applications are easily accomplished with MULTIROL CF Series bearings.

Constructed with extra heavy outer race sections to take shock load and many small diameter rollers to evenly distribute heavier radial loads . . . result is smooth performance at high speed and reduced power requirements not possible with bolt and roller units.

Lubrication is simplified with facilities provided for greasing and constant oiling and frequent adjustment due to rapid wear of plain bushings is eliminated.

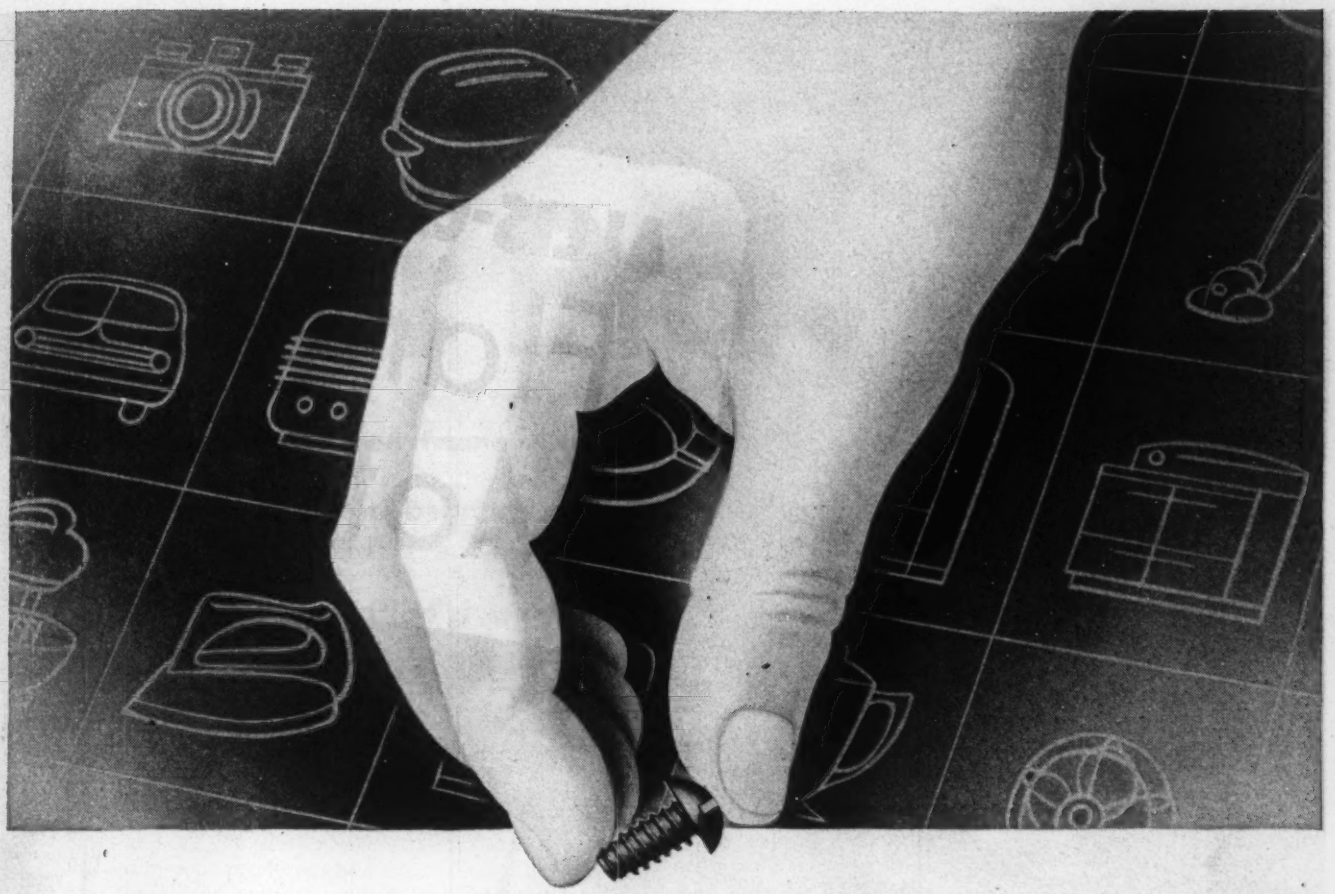
Design these many anti-friction advantages into your machines with CF Series bearings for conventional stud mounting. Use the CYR Series bearings for shaft mounting without stud.

Easily applied and available in many standard sizes from conveniently located stocks. *Write today for our engineering department's helpful recommendations.*



Address McGill Manufacturing Company, Inc. 200 No. Lafayette St., Valparaiso, Indiana for your copies of Bulletins CF-40 and CY-48

McGILL
TRADE MARK
precision bearings



How Parker-Kalon Helps You

FIT THE FASTENER TO THE JOB

To Reduce Assembly Costs

In designing for lower costs, have you questioned the efficiency of the *fasteners* you use? In 7 out of every 10 cases, Parker-Kalon Self-tapping Screws permit savings up to 50% in assembly work hours.

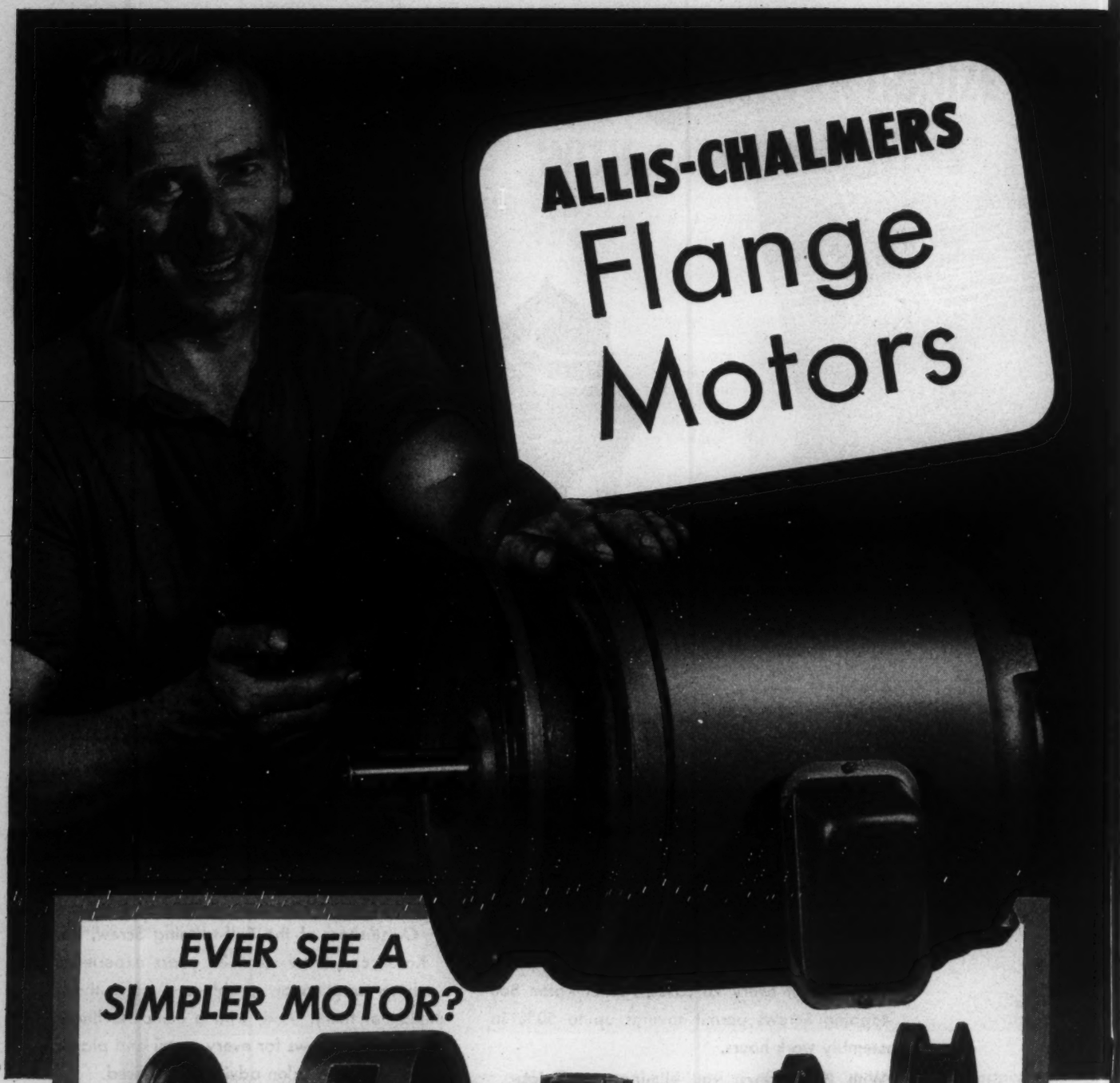
With P-K Screws, you eliminate such job-slowing operations as tapping, riveting, nut-running, and inserts in plastics. But other big advantages — simplified assemblies, lower production costs, and often improved product performance — lie in Parker-Kalon's ability to *fit the fastener to the job.*

Originators of the Self-tapping Screw, Parker-Kalon can draw upon 35 years experience in solving application problems — more than a million of them. And, with a complete line of Self-tapping Screws for every metal and plastic assembly, Parker-Kalon advice is unbiased.

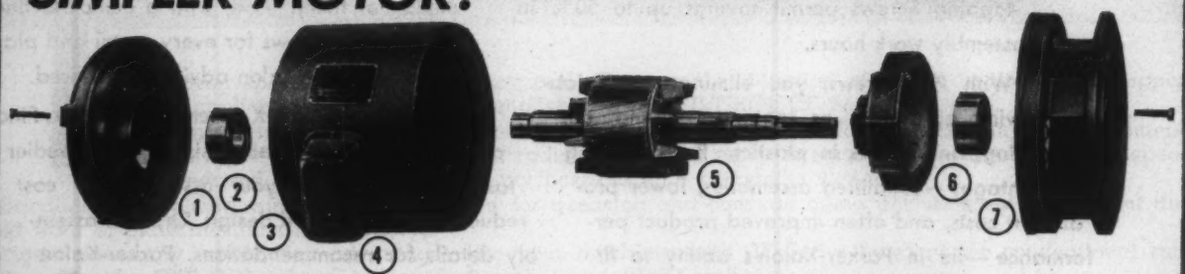
Today — call in a P-K Assembly Engineer. Find out the possibilities of using this simpler, speedier fastening method in your assembly for cost reduction and improved design. Or, mail assembly details for recommendations. Parker-Kalon Corporation, 200 Varick St., New York 14, N. Y.

Remember
IF IT'S P-K® ... IT'S O.K.!

The P-K® PARKER-KALON®
SELF-TAPPING SCREWS
FOR EVERY METAL AND PLASTIC ASSEMBLY



EVER SEE A SIMPLER MOTOR?



① Steel guard directs air stream toward stator windings for efficient cooling. ② Pre-lubricated ball bearings are simple press fit on motor shaft, they require no further lubrication for years. ③ Rigid, cast iron frame completely surrounds and protects stator core. ④ Diagonally-split conduit box is adjustable to any angle . . . is roomy . . . easy to get at. ⑤ Pressure-cast rotor has integrally cast fans . . . no welds or rivets . . . there's nothing to rattle or shake loose. ⑥ Balanced ventilating fan is keyed to rotor shaft . . . produces strong blast of cooling air. ⑦ Flange is counterbored for oil seal . . . has protecting mesh screens.

Sold — Applied — Serviced by Authorized Dealers, Certified Service Shops, and District Offices Throughout U. S.

ALLIS-

GIVE YOUR PRODUCT THIS 4-Point Motor Protection

1. ***Rigid cast iron frame*** completely surrounds all working parts . . . resists corrosion!

2. ***Pre-lubricated bearings*** eliminate bearing maintenance . . . require no further lubrication for years.

3. ***Double-insulation*** gives *extra* protection against heat, moisture, and corrosion.

4. ***Pressure-cast rotor*** has no rivets or welds . . . is indestructible in normal service.

Available in three flange types . . . sizes to 150 hp in open, enclosed and protected types, with electrical and mechanical modifications to suit specific requirements.

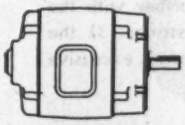
HERE'S A LINE OF FLANGE MOTORS you can design into your products and forget! Notice how *compact* these motors are . . . how *trim* in appearance. Further, their large, roomy conduit boxes and clearly marked connections make them *easy to install.*

Notice how the outer frame completely protects all working parts. This feature combined with pre-lubricated bearings and pressure cast rotors adds up to "all-around" protection against distortion, corrosion, friction and entrance of foreign matter. And bell housing is drip-proof, at no extra cost!

Best of all, these Allis-Chalmers motors are backed by a long-established record for building as tough and sturdy a line of motors as you can find anywhere on the motor market.

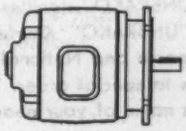
Check your needs in the coupon below for additional information.

3 TYPES HANDLE MOST OEM JOBS



C FLANGE TYPE — Generally used for close coupling to pumps. Employs rabbet fit with mounting holes on smaller diameter than rabbet fit. Holes tapped for mounting bolts.

D FLANGE TYPE — For machine tool applications. Uses rabbet fit with mounting holes on larger diameter than rabbet. Holes are clearance holes with bolts usually assembled from motor side.

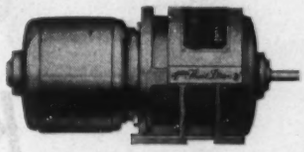


P BASE TYPE — Generally used for vertical applications. Employs rabbet fit with mounting holes on larger diameter than rabbet. Holes are clearance holes.

Texrope is an Allis-Chalmers trademark.

AMERICAN BLOWER GYROL FLUID DRIVES USE ALLIS-CHALMERS MOTORS

New Type TM Gyrol Fluid Drives offer benefits of low starting current, smooth acceleration and shock absorption in the 1 to 20 hp range.



These packaged power drives use Allis-Chalmers constant speed a-c flange motors to produce a smooth start. The motors come up to 85% of full speed before assuming load. Acceleration is gradual and there is a 50% saving in the amount of current consumed for starting. This unit makes overmotoring unnecessary and eliminates shocks to machinery. Overload protection is positive and can be adjusted by changing oil level in the unit. For additional information contact American Blower Corporation, Detroit 2, Michigan.

Check This Coupon

ALLIS-CHALMERS, 1001A SO. 70 ST.
MILWAUKEE, WIS.

Please send me:

- ☐ Flange Motor Specification Sheet (5157324).
- ☐ Handy Guide to Electric Motors (5186052).
- ☐ General Purpose Motor Controls (1487132).
- ☐ Equipment for Machine Tools (2587110) (Contains information for OEM users on Motors, Texrope drives, Motor Controls, Coolant Pumps.

Name..... Title.....

Company.....

Street.....

City..... State.....

A-2876

CHALMERS

A-C ALLIS-CHALMERS

Because of its Knurled Head . .

. . SCREWS IN FASTER AND FURTHER BEFORE A WRENCH BECOMES NECESSARY . . . . .

UNBRAKO KNURLED SOCKET HEAD CAP SCREW

There is a definite saving of assembly time when you use "UNBRAKO" Socket Head Cap Screws with Knurled Heads. The exclusive Knurled Heads perform triple duty: (1) the *Knurling* provides a sure, slip-proof grip; (2) the *Knurling* speeds assembly, because it enables the "UNBRAKO" to be screwed in faster and further with the fingers—handiest of all wrenches—before a "key" becomes necessary; (3) the *Knurling* permits positive locking—a feature so often essential where there is excessive impact or vibration.

As always, the brand name "UNBRAKO" signifies *extra strength* and *precision manufacture to close tolerances*. "UNBRAKO" *Knurled* Socket Head Cap Screws are available in both National Coarse and National Fine Thread Series in a full range of standard sizes. Other sizes to special order. Write us for your free copy of the "UNBRAKO" Catalog and the name of your nearest "UNBRAKO" Distributor.

Knurling of Socket Screws originated with "Unbrako" in 1934.

Other "UNBRAKO" Products Include: Socket Set Screws with Knurled Cup Points, Socket Set Screws with Knurled Threads, Square Head Set Screws with Knurled Cup Points—all patented Self-Locking screws that *won't shake loose!* Knurled Socket Head Stripper Bolts. Precision-Ground Dowel Pins. Fully-Formed Pressure Plugs.

SPS STANDARD PRESSED STEEL CO.

BOX 102, JENKINTOWN, PENNSYLVANIA

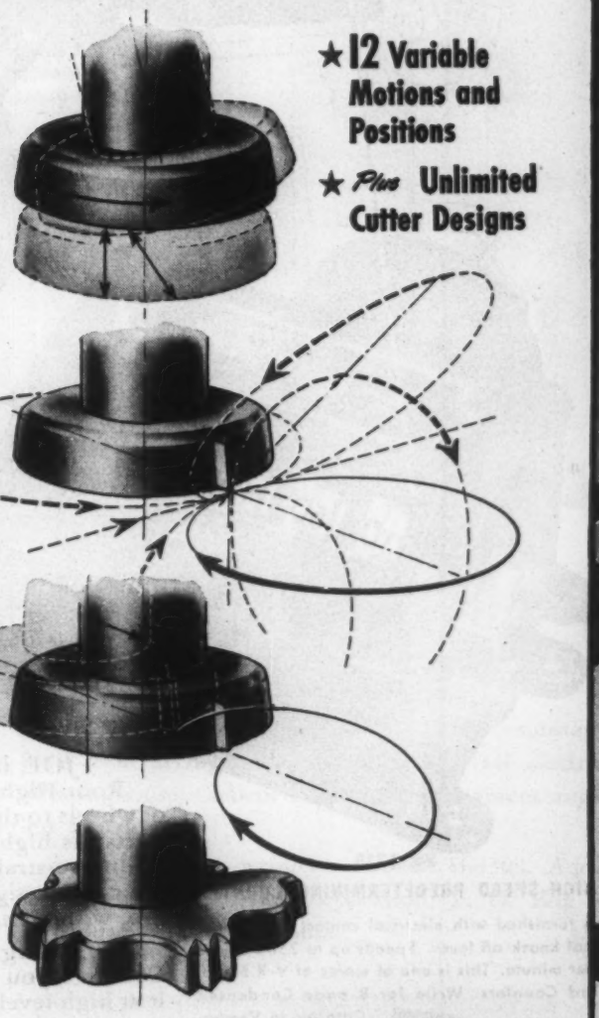
"Serving Industry continuously since 1903 through Industrial Distributors"

What Every Designer Should Know

about the versatile Gear Shaper and its ability to cut costs in quantity production of all types of Contours.

Reciprocating Generation

THE BASIS OF UNPARALLELED GEAR SHAPER VERSATILITY



Fellows

For an interesting perspective on the broad range of Gear Shaper applications ask for our 48-page booklet, "The Art of Generating with a Reciprocating Tool". Write: The Fellows Gear Shaper Co., Head Office and Export Dept., Springfield, Vermont. Branch Offices: 616 Fisher Bldg., Detroit 2, 640 West Town Office Bldg., Chicago 12, 7706 Empire State Bldg., New York 1.

"Here's what I count on ...to keep me on top of my job!"

JOE, here, has a mighty dependable assistant in this Veeder-Root High-Speed Predetermining Counter. He pre-sets one bank of wheels to the exact number of pieces he needs on any run. Then he starts his high-speed machine *and forgets it* . . . or does other work! No nerve-strain. No eye-strain. No guesswork. *And no waste* . . . for the counter signals him or acts to stop the machine right on the button, without either shortage or surplus.

Yes, among the many economies and advantages of Veeder-Root Counters, you can count on them to boost workers' morale and keep it at high level. That's one of the reasons why management and plant operating heads are coming more and more to specify production machines and equipment featuring *built-in* Veeder-Root Counters. And *that's* why it's smart salesmanship to build Veeder-Root Counters into *your* product . . . to bring a new utility to your customers. But how to do it? That's for us to show you. Just write.

VEEDER-ROOT INCORPORATED, HARTFORD 2, CONNECTICUT

No. 1239

HIGH-SPEED PREDETERMINING COUNTER

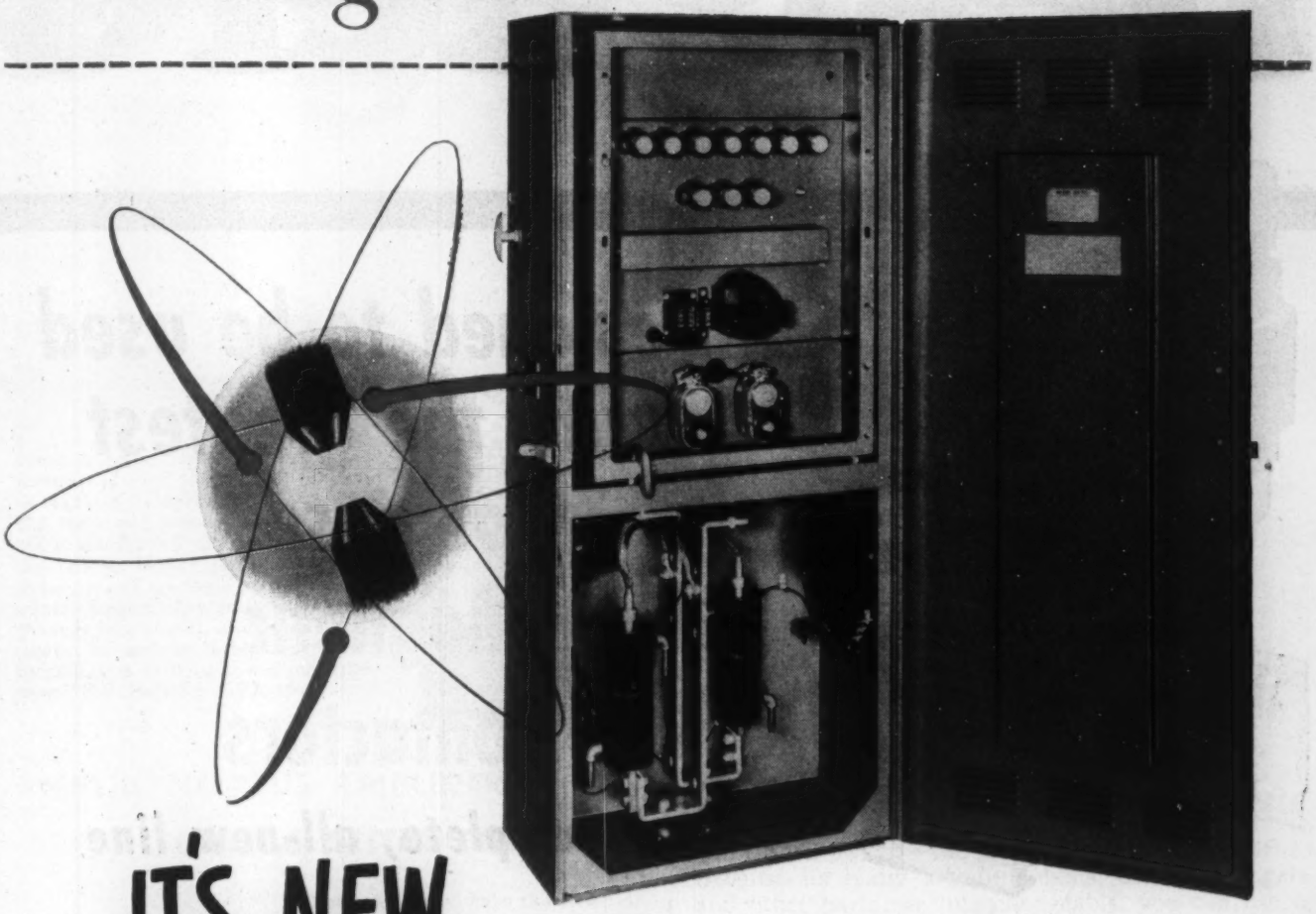
is furnished with electrical contact or mechanical knock-off lever. Speeds up to 2500 counts per minute. This is one of scores of V-R Standard Counters. Write for 8-page Condensed Catalog to Veeder-Root Incorporated, Hartford 2, Conn.

Veeder-Root COUNTERS

In Canada: Veeder-Root of Canada, Ltd., 955 St. James Street, Montreal 3
In Great Britain: Veeder-Root Ltd., Kilspindie Rd., Dundee, Scotland

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



IT'S NEW . . .

it's fully electronic!

Look inside the new Westinghouse Resistance Welding Control and you'll spot many important advances in control design: reduced size . . . fewer components . . . a control panel that lifts out of place easily and individual control panels that can be removed separately. You'll find pay-off features everywhere.

You'll find something missing, too, but that's what makes this the most dependable control of all. By making every timing function fully electronic, virtually all moving parts have been eliminated. And when you consider the constant trip-hammer pounding of mechanical contactors and relays you understand why quiet, efficient, fully electronic operation means fewer costly breakdowns, less down time, less lost production.

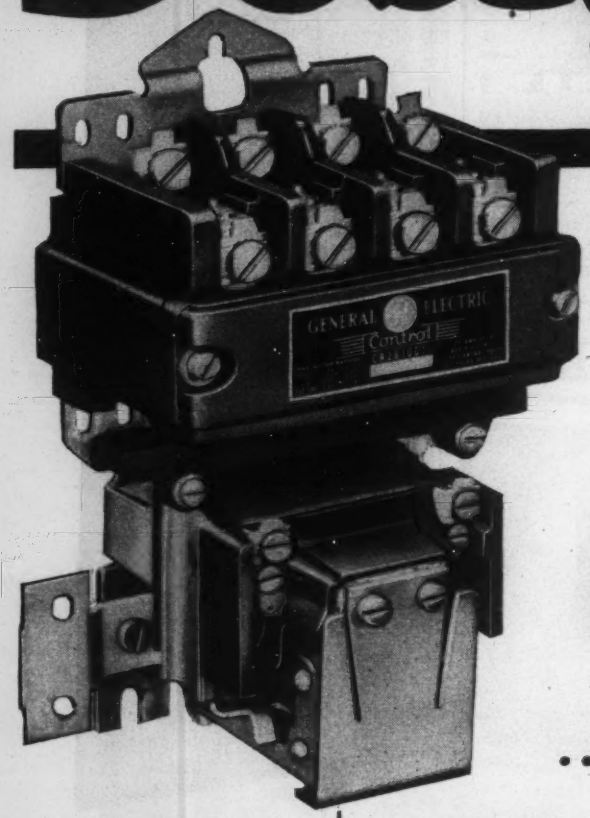
This kind of dependability brings substantial long term savings that make the new all electronic Westinghouse Control the wisest investment regardless of price.

For full details, write for booklet B-4309. Address Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21535

Westinghouse

RESISTANCE WELDING CONTROL

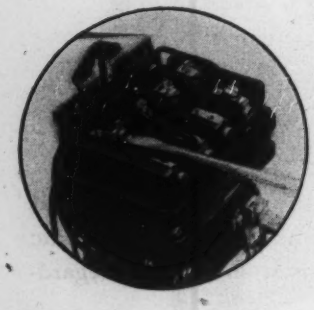
Designer's



Designed to be used with the greatest of ease!

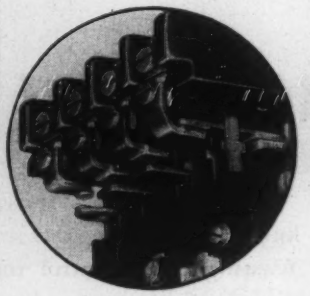
Magnetic Contactors

...in a complete, all-new line



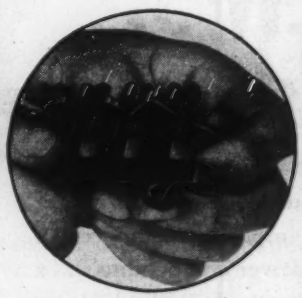
EASY TO WIRE

All terminals can be reached from the front; large pan-head screws give ample bearing surface for screwdriver. Just strip wires, slide them under terminal clamp which rides out with the screw, and tighten screw. These new G-E a-c contactors are available in NEMA sizes 00, 0, 1, 2, and 3, rated up to 50 hp at 440 volts.



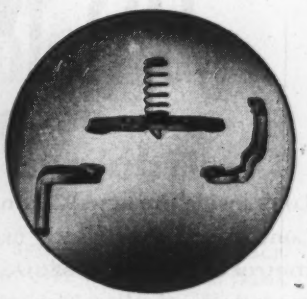
EASY TO INSPECT

By loosening two captive screws to lift off the burn-resistant arc hood, you quickly, completely expose the contacts, simplifying inspection and maintenance. All contacts can be removed without disturbing connections to terminals. A screwdriver is all you need for inspection.



EASY TO CHANGE CONTACTS

In sizes 00, 0, and 1, contacts can be changed from normally open to normally closed (or vice-versa) with no extra parts. Just remove two screws and take out the moving contact head. Then depress the spring slightly (it's held in place permanently), roll out and reverse the contact.



EASY TO CHANGE INTERLOCKS

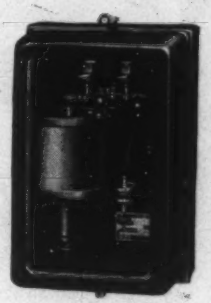
To meet individual control circuit needs, interlocks in all sizes can be changed from normally open to normally closed, just like the main contacts. Extra double-circuit interlocks with interchangeable contacts are quickly added to either side of the contactor. This means *four* extra interlocks! See Bulletin GEA-5154.

GENERAL ELECTRIC

Digest

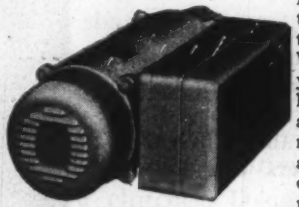
PRODUCT HIGHLIGHTS

SENSITIVE RELAYS FOR MANY OPERATIONS!



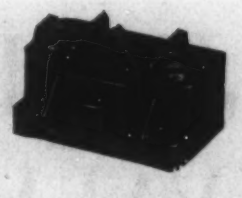
Need a highly sensitive, extremely accurate device to control, protect, or regulate an operation? You'll find the right one among General Electric's standard Type GTR a-c and d-c relays. Unlike ordinary relays, these devices are made to operate on minute frequency, voltage or current changes in a circuit, and, where necessary, to initiate corrective action. Enclosure is dust-tight and moisture proof. See Bulletin GEA-2961.

AMPLIDYNE PLUS AMPLIFIER EQUALS BETTER CONTROL!

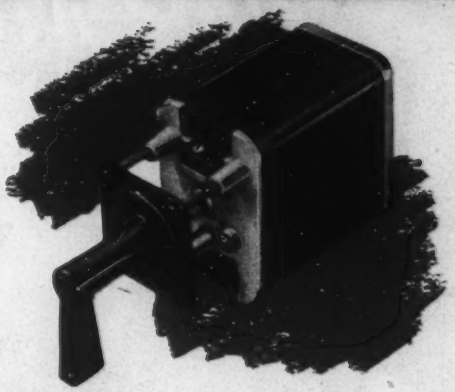


Note the many ways the General Electric electronic amplidyne can help in many types of motor control where you need precise regulation of current, voltage, and speed. With this versatile packaged unit, you can cover wide speed ranges, limit loads, hold tension, speed up acceleration, and position accurately. Providing instant response and high amplification, the G-E electronic amplidyne can be applied to the control of motors from ¼ hp to 200 hp. See Bulletin GEA-4889.

STURDY SPACE-SAVER —THE SIZE 2 SWITCHETTE!



Where space is limited, use this compact, sturdy General Electric Size 2 Switchette to control small-motor drives, for limit-switch applications, and in various electronic, industrial heating, and other control circuits. Approximately 2 x 1 x 1 inches, it weighs only two ounces. Snap action, double-break-contact construction gives it a current rating up to 25 amperes at 230 volts a-c or 24 volts d-c—makes it withstand severe vibration. See Bulletin GEC-207.



Switch to the Switch

WITH 10,000 USES!

Yes, more than 10,000 circuit combinations and operation sequences are possible with this versatile control and tranfer switch—the General Electric Type SB-1. Because its many *standard* cams, contacts, fingers and other parts are interchangeable, you can use it for practically any control job on almost any low-capacity circuit. Construction features include silver-to-silver contacts, anti-arcing barriers between adjacent circuits, and sturdy Textolite face plates.

For extra-heavy duty, the rugged Type SB-9 has all these features plus wear-resistant extra strength built into every part—contacts, gears, shunt connections, and even the handles.

Both the SB-1 and SB-9 mount on panels ⅛ to 2 inches thick, are rated up to 20 amperes at 600 volts a-c or d-c. And standards are ready on only four weeks' delivery! See Bulletins GEA-4746 (SB-1), and GEA-4114 (SB-9).

General Electric Company, Section E668-76
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

- ☐ GEA-2961—Type GTR relays
- ☐ GEA-4114—Type SB-9 switch
- ☐ GEA-4746—Type SB-1 switch
- ☐ GEA-4889—Electronic amplidyne
- ☐ GEA-5154—A-c motor contactors
- ☐ GEC-207 —Size 2 switchette

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In plants handling corrosive liquids, or fluids that must be kept free from contamination or discoloration, Stainless Steel Valves must be not only the right *type*, but fabricated of the *proper* alloy for the service.

To keep production at peak, and down-time for repairs and replacements to a minimum, alert management chooses Jenkins Stainless Steel Valves. Built to the same quality standard which has made "Jenkins" the preferred industrial valve, Jenkins Stainless Steel Valves are available in a range of sizes to meet almost any service requirement.

Equally important, however, is Jenkins Engineering Service. Providing information you need to select the alloy or type of valve which will render the best service (based on analysis of specific information about the valve installation), Jenkins engineers can be of valuable assistance.

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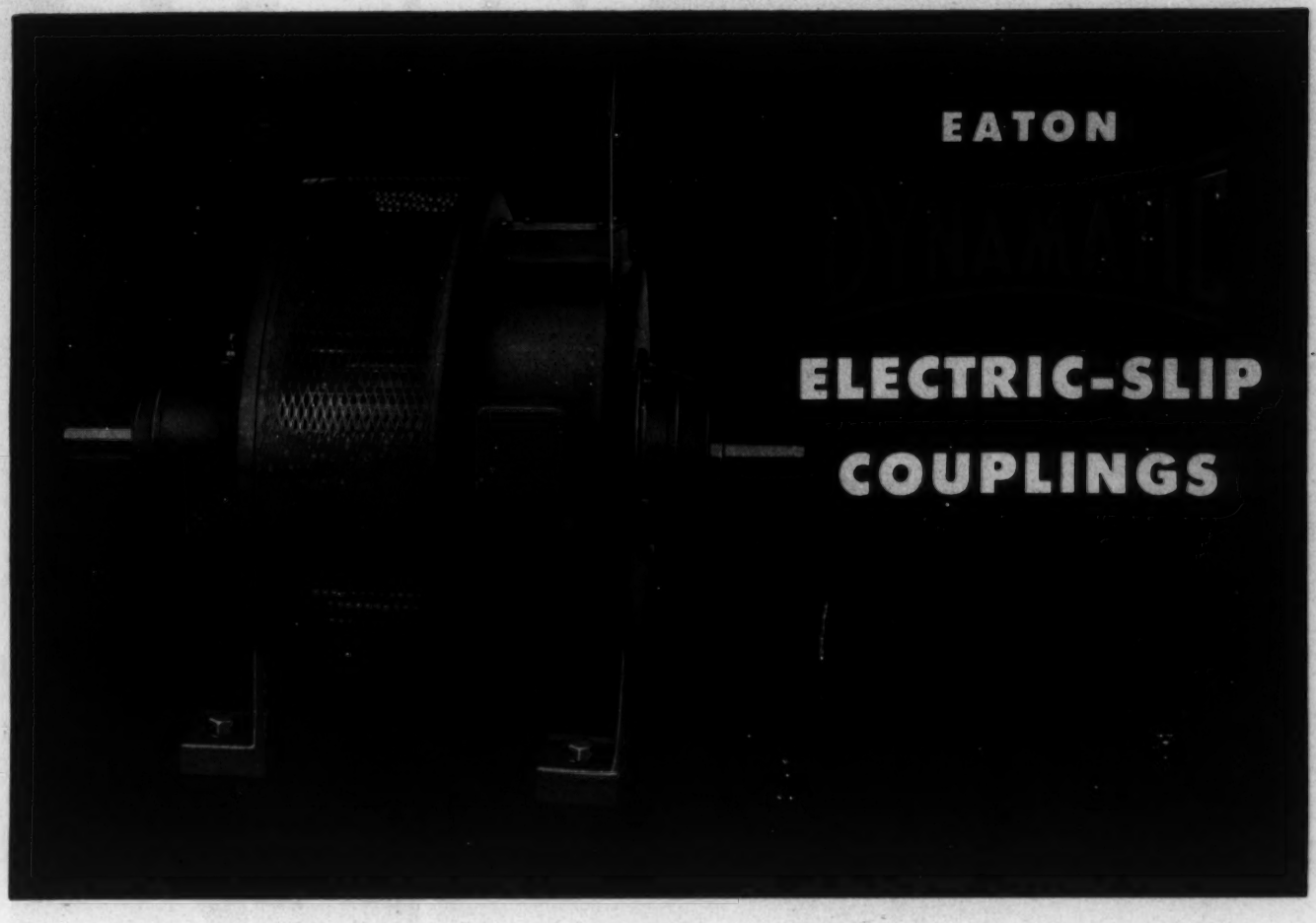
JENKINS VALVES

LOOK FOR THE DIAMOND MARK

SINCE 1864 TRADE JENKINS MARK



Variable Speed from Constant Speed Source

Dynamatic Electric-Slip Couplings can be applied to any shaft, in any type of machine to transmit motion from one rotating member to another without mechanical contact, without friction, without shock, and under complete control. Used as variable speed drives, power couplings, or slipping clutches, Dynamatic units have a wide range of industrial applications.

Dynamatic electric-slip couplings are a simple, compact, frictionless means of providing variable speed from a constant speed source, or constant speed from a variable speed source, with smooth, full-torque starts and cushioned stops. Outstanding characteristics are infinitely variable control, instantaneous response, quiet operation, low maintenance, electronic control.

Dynamatic couplings are available in both air-cooled and water-cooled types. The air-cooled couplings are designed to be powered by electric motors or engines at relatively constant speed; the output speed can be readily controlled and regulated. Sizes range from 1/4 hp to thousands of hp. Typical applications: fan and blower drives, centrifugal pump drives, calenders, extruders, wire drawing machines, draw benches, and printing presses.

Dynamatic water-cooled variable speed couplings are particularly adapted to installations in dusty or corrosive atmospheres, or wherever explosion-proof protection is necessary. Silent operation is a desirable feature. Sizes range from 10 hp to 1500 hp. Write for illustrated literature.

EATON MANUFACTURING COMPANY • CLEVELAND, OHIO
ADDRESS INQUIRIES TO: DYNAMATIC DIVISION • KENOSHA, WISCONSIN

PRODUCTS: SODIUM COOLED, POPPET, AND FREE VALVES • TAPPETS • HYDRAULIC VALVE LIFTERS • VALVE SEAT INSERTS • ROTOR PUMPS • MOTOR TRUCK AXLES • PERMANENT MOLD GRAY IRON CASTINGS • HEATER-DEFROSTER UNITS • SNAP RINGS • SPRINGTITES SPRING WASHERS • COLD DRAWN STEEL • STAMPINGS • LEAF AND COIL SPRINGS • DYNAMATIC DRIVES, BRAKES, DYNAMOMETERS

Failures Eliminated Weight Reduced 18% Savings with STEEL CASTINGS

As originally produced, this cable winch flange collapsed on numerous occasions, requiring replacement.

Faced with the problem of finding a way to eliminate these failures—a serious matter in the oil field where this equipment is used — the manufacturer turned to steel castings.

By eliminating the principal cause of failure—lack of rigidity—and by providing high resistance to fatigue and vibration, steel castings gave the degree of dependability required, with a reduction in weight from 1,400 to 1,150 pounds.

Although cost of the part was about the same, manufacturer saved time and money by eliminating storage and maintenance of jigs, fixtures, and templates necessary for fabrication of the part as a weldment.

* * *

Conversion of some of *your* highly stressed parts to steel castings may result in equal if not greater benefits than those given here.

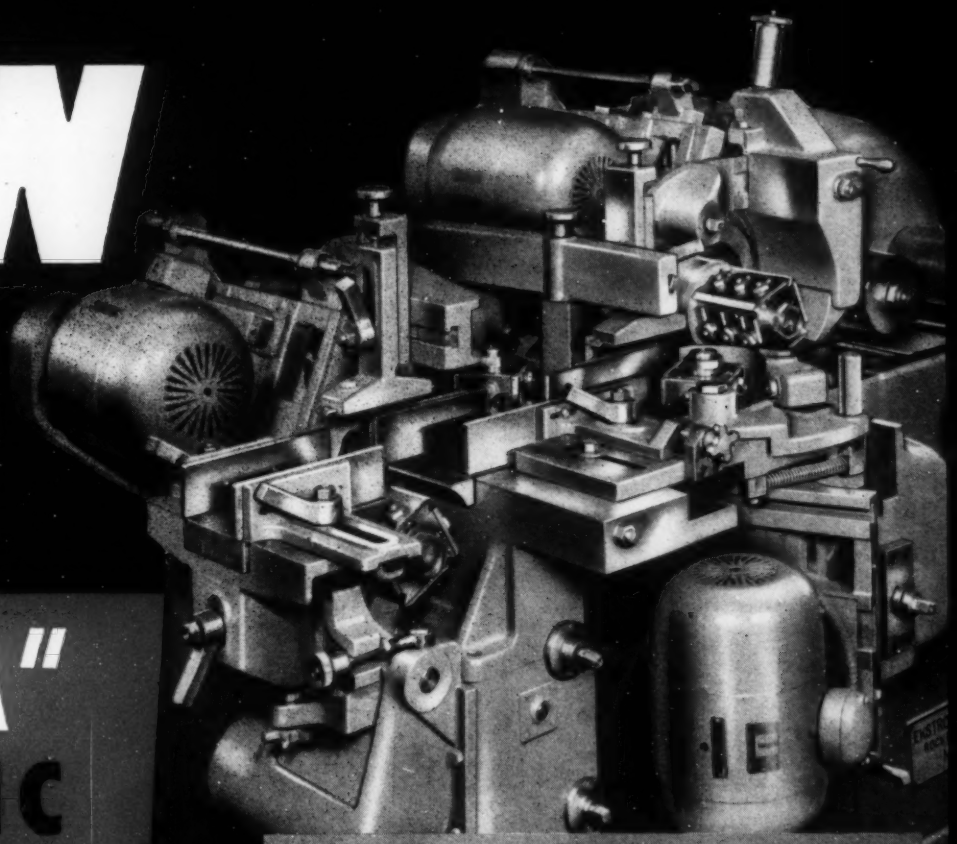
Also in new and redesigned parts, your steel foundry engineer may be able to suggest ways to cut costs and weight and obtain other substantial benefits . . . if you call him in for a discussion *while your product is still on the drawing board.*

This service is offered without cost or obligation. It makes available through your foundry engineer the full results of the development and research program carried on by Steel Founders' Society of America.

STEEL FOUNDERS' SOCIETY OF AMERICA

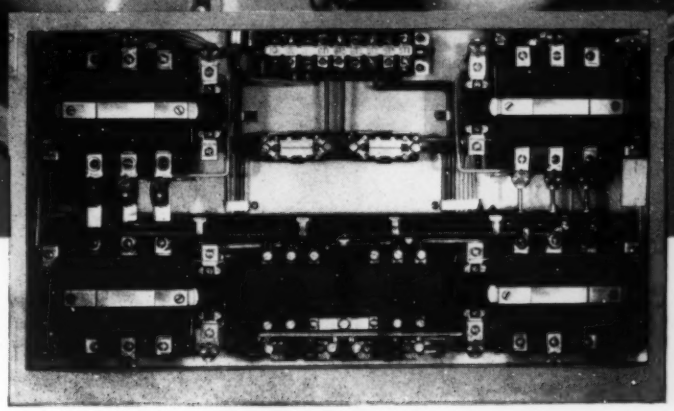
NEW

ARROW AH HART



TYPE "RA" MAGNETIC STARTERS

SIZE 2

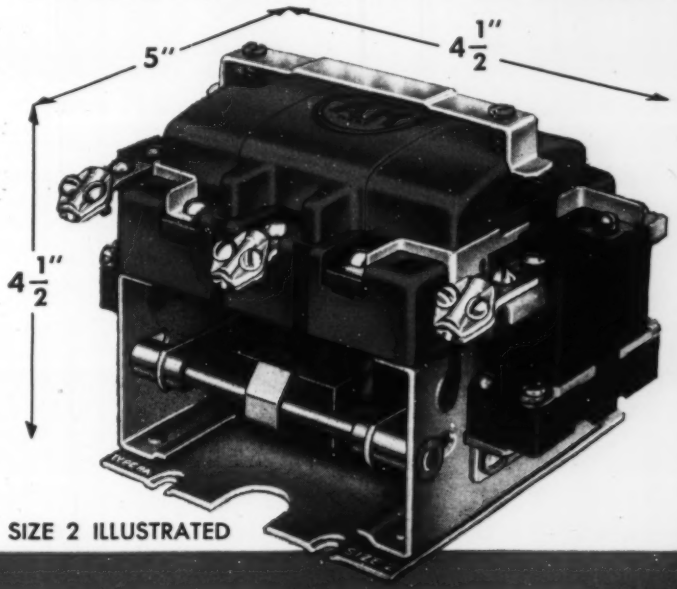


Versatile IN APPLICATION IN PERFORMANCE

The Ekstrom Carlson moulder features a special control panel designed and built by W. F. and John Barnes. This panel, only *14" x 22"*, contains four Arrow-Hart Size 2 magnetic starters and one Size 1 magnetic reversing starter, with a unique center line wiring plan. These design innovations were made possible by the use of Arrow-Hart's new "RA" line of motor starters that are only 1/2 the size of conventional starters. This compact panel has a capacity of over *100 H.P.* of divided motor controls with room to spare.

NEW RIGHT ANGLE BALANCED MECHANISM SAVES SPACE, PERMITS UNUSUAL LAYOUTS

Arrow-Hart's new right angle balanced mechanism has a knee-action bellcrank fulcrum, which transfers the leverage from a vertical to a horizontal plane. This multiplies the leverage and increases contact pressure. Greater power, finer balance, versatility — in an ingeniously compact design that cuts conventional starter size in half — all of this is due to the amazing new right angle, fail safe, balanced mechanism developed by Arrow-Hart.



SIZE 2 ILLUSTRATED

CONTROLS and APPARATUS FOR *Outstanding* PERFORMANCE

ARROW AH HART

ARROW·HART

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 HAWTHORN ST., HARTFORD 6, CONN., U. S. A.

SMALLEST STARTER ON THE MARKET

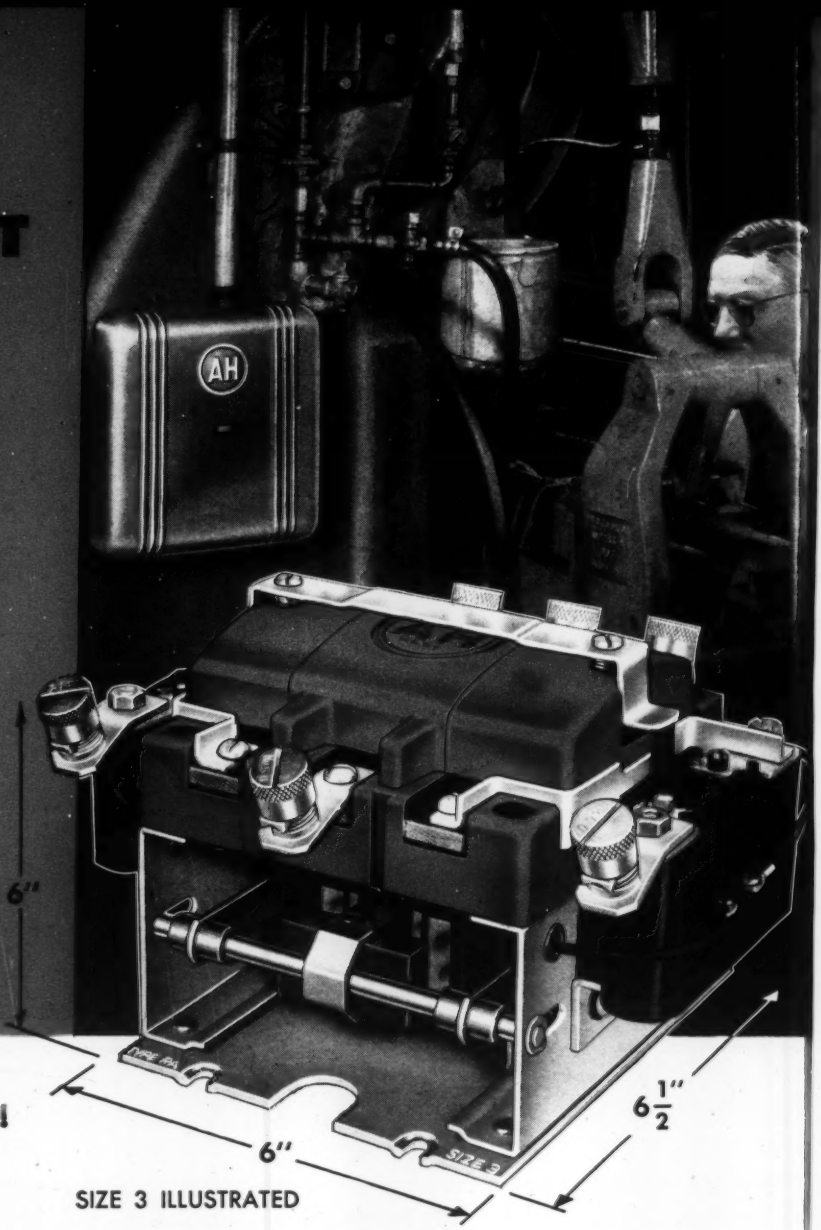
Features

BALANCED MECHANISM

Exclusive in

ARROW AH HART

SIZES 2 and 3 "RA" MAGNETIC STARTERS



SIZE 3 ILLUSTRATED

COMPACT—½ the size of conventional starters!

EASY TO WIRE AND SERVICE

Straight through wiring reduces bending and forming of heavy wires. Terminals are front wired. Line and load wires connect at opposite ends. **SAFE AND DEPENDABLE** High power at low wattage. Tough, dependable overload relay, with bimetallic inverse time element. Interchangeable heaters. **NEW, TOUGHER CONTACTS** A broad line-of-contact surface. Curved and movable against flat and stationary contacts. Tips of special silver alloy brazed to copper. **PLASKON ALKYD BASE AND HOOD** New tested Plaskon Alkyd molding compound used in protective base and hood. Exceeds arc resistance of next best material by 50% to 60%.

SIZE 2 MAX. H.P.

Volts	110	220	440	550
Single Phase	3	7½	10	10
Polyphase	7½	15	25	25

SIZE 3 MAX. H.P.

Volts	110	220	440	550
Single Phase	7½	15	25	25
Polyphase	15	30	50	50

WRITE TODAY FOR LITERATURE ON ARROW-HART TYPE "RA" MAGNETIC STARTERS AVAILABLE IN LOCAL AND REMOTE CONTROL OR SELECTOR SWITCH TYPES IN SIZES 0, 1, 2 and 3

Buy with Confidence
Profit by Performance

ARROW AH HART

THE ARROW-HART & HEGEMAN ELECTRIC CO.

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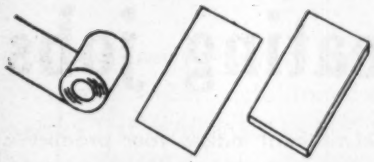
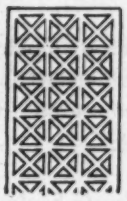
PIG AND INGOT FOR CASTING

You Make the Castings—
Reynolds Will Supply the Aluminum

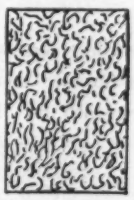
SHEET AND PLATE



EMBOSSED AND PERFORATED SHEET



Six Embossed Patterns—Stucco, Rib Lengthwise, Rib Crosswise, Diamond, Square, Leather Grain

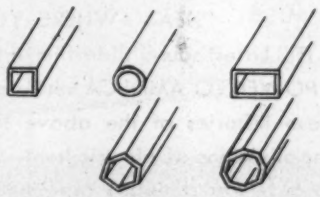


Four Perforated Patterns—Cane, Union Jack Style A-1, Largex

WIRE, ROD, BAR AND FORGING STOCK

STRUCTURAL AND EXTRUDED SHAPES

TUBING AND PIPE

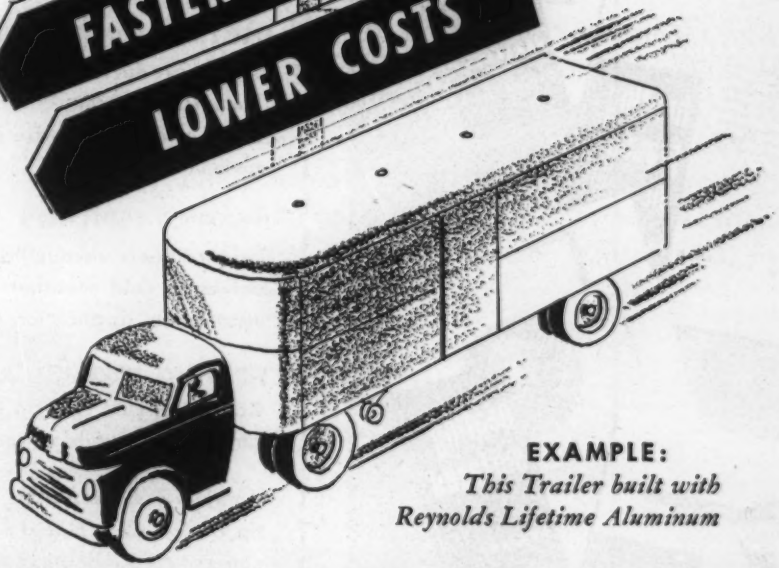


IF YOU SEE RUST YOU KNOW IT'S NOT ALUMINUM

REYNOLDS METALS

The ALUMINUM OUTLOOK

BETTER PRODUCTS
FASTER PRODUCTION
LOWER COSTS



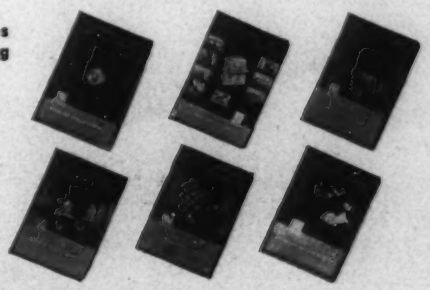
EXAMPLE:
This Trailer built with Reynolds Lifetime Aluminum

RUGGED trailer-tractor combinations can now carry 10 to 25% more payload—without violating state highway load limits. Cargo is substituted for dead weight when these "big jobs" are built with aluminum. Less net weight means longer tire wear, faster transportation and less fuel per ton mile. Maintenance cost is cut, longer life assured when Reynolds *Lifetime* Aluminum is specified.

See how aluminum with its many advantages—⅓ the weight of ordinary metals, no red-rust threat, often no finishing costs, more eye appeal—offers production and sales benefit for your product. Call the nearest Reynolds Distributor or Sales Office, listed under "Aluminum" in your classified telephone directory, or write Reynolds Metals Company, Aluminum Division, 2521 South Third Street, Louisville 1, Kentucky.

Alloy Data **Structural Design** **Finishes**
Heat Treating **Machining** **Welding**

Request any of these helpful, illustrated booklets on your company letterhead and they'll be mailed to you without charge. Informative and understandable, you can use them to answer questions relating to your design and production. Just write to address above.



REYNOLDS *Lifetime* ALUMINUM

CONSIDER ALUMINUM — CONSULT REYNOLDS — THE COMPLETE ALUMINUM SERVICE

send for these Free Bulletins

for your heating jobs

HEATING LIQUIDS "Built-in" electric heat makes your product a better product because it *puts the heat right where it is wanted!* "Immersion heating" with G-E Calrod* heaters places heat source into the material to be heated . . . for maximum heat transfer with minimum heat losses.

HEATING PIPELINES G-E heating cable and Calrod tubular heaters keep viscous liquids free-flowing and protect pipelines and valves in cold weather . . . a wealth of "how to" information on installation, application and power requirement calculation.

HEATING PROCESS AIR How and where to apply G-E strip, Calrod tubular and fin Calrod heaters for drying, baking, warming, curing and a wide range of industrial processes and equipments.

HEATING SURFACES Whether it's an eighth-inch soldering iron tip or 100 square-feet of platen surface, this bulletin tells you how to calculate your heating requirements . . . which G-E Calrod heater to use and where and how to install it.

MELTING SOFT METALS Here's how you can achieve fast melting and fully automatic temperature control of babbitt, solder, lead, tin, and type metals—with reduced operation costs, less maintenance, and cooler working conditions.

ELECTRIC HEATERS AND HEATING DEVICES New revised catalog lists a wide variety of heaters and devices to meet almost any conceivable heating requirement.

DON'T MISS "HEAT—WHERE YOU WANT IT!" Latest sound slide-film in the *MORE POWER TO AMERICA* series depicts case histories of the above five basic applications of electric heat. Ask your local power company representative or contact the nearest G-E Sales Office.

BEFORE you design your electrically heated machinery or equipment . . .

BEFORE you convert existing installations . . . consult the G-E apparatus salesman who regularly calls on you or a G-E Industrial Heating Specialist . . . his recommendations will pay you real dividends in terms of more efficient heating and better designs. *Reg. U.S. Pat. Off.

GENERAL ELECTRIC

CUT ALONG DOTTED LINE

check Check these publications (above) you want for your particular applications and mail today to:

Apparatus Dept., Sect. 700-8,
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Name .....

Company .....

Address .....

City ..... State .....

USE "O" RING SEALS

(The modern packing method)

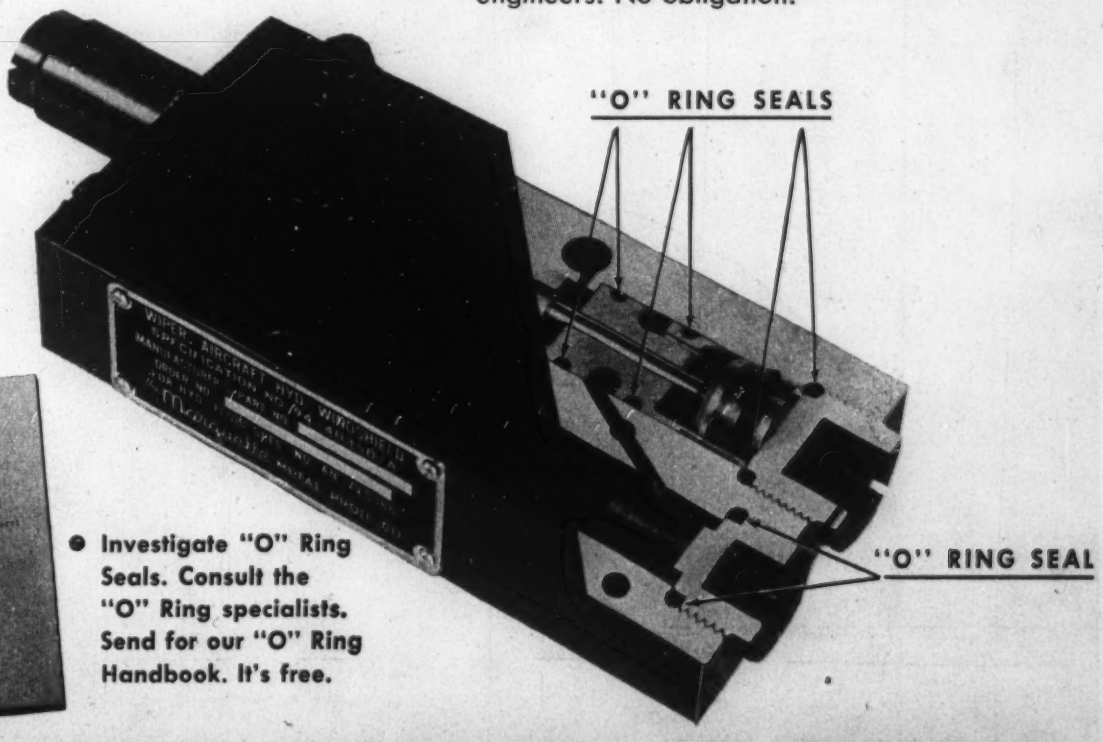
for SIMPLICITY · RELIABILITY · LOW COST · SPACE SAVINGS

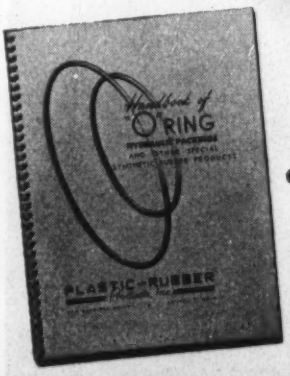
The cut-away view of this, D5000 hydraulic windshield wiper actuator assembly—manufactured by THE MARQUETTE METAL PRODUCTS CO., Cleveland, Ohio—shows 4 of the 6 "O" Ring Seals used. Employed on all types of military and commercial aircraft, the Marquette assembly actuates wipers at a rate of 300 strokes per minute, on 3000 PSI systems.

This is another good example of the way "O" Ring Seals save weight, aid compactness, effect simplicity of design, and reduce production costs.

"O" Rings are made from selected synthetic rubber compounds for leakproof service with gases, water, oils and special fluids.

Perhaps *you* have a product now in design or production which would benefit immeasureably by "O" Ring application. Why not find out? Discuss your products and problems with our PRP field engineers. No obligation.

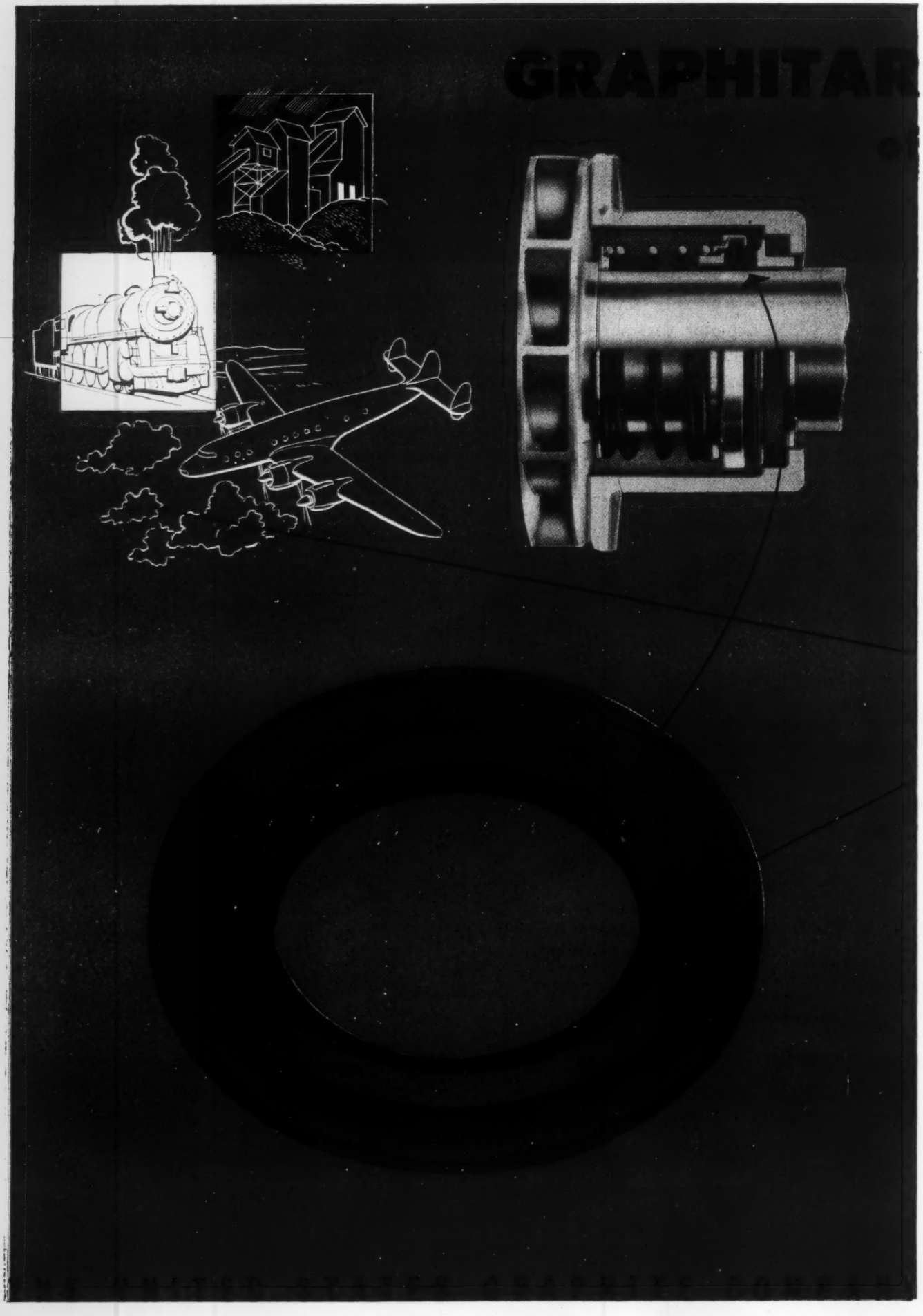




● **Investigate "O" Ring Seals. Consult the "O" Ring specialists. Send for our "O" Ring Handbook. It's free.**

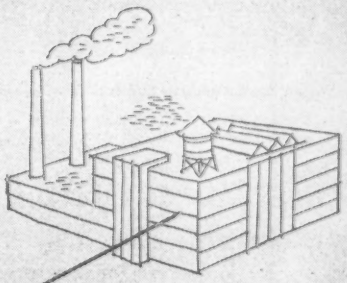
PLASTIC and RUBBER
Products, Inc.

Box 431, Dayton 1, Ohio


GRAPHITAR

assures successful operation high speed liquid seals

Gits Specifies Graphitar for Oilseal Assembly To Solve High Speed Sealing Problem



● Keeping the lubricating oil separated from liquids being pumped at high speeds and pressures was a problem for the Gits Brothers Manufacturing Co. of Chicago, until they specified Graphitar for the nose piece of their oil-seal assembly for pump manufacturers. Now the Graphitar seal helps *keep pumps operating smoothly* despite operating conditions of 150 psi pressure, 4000 RPM and 150°F. temperatures.

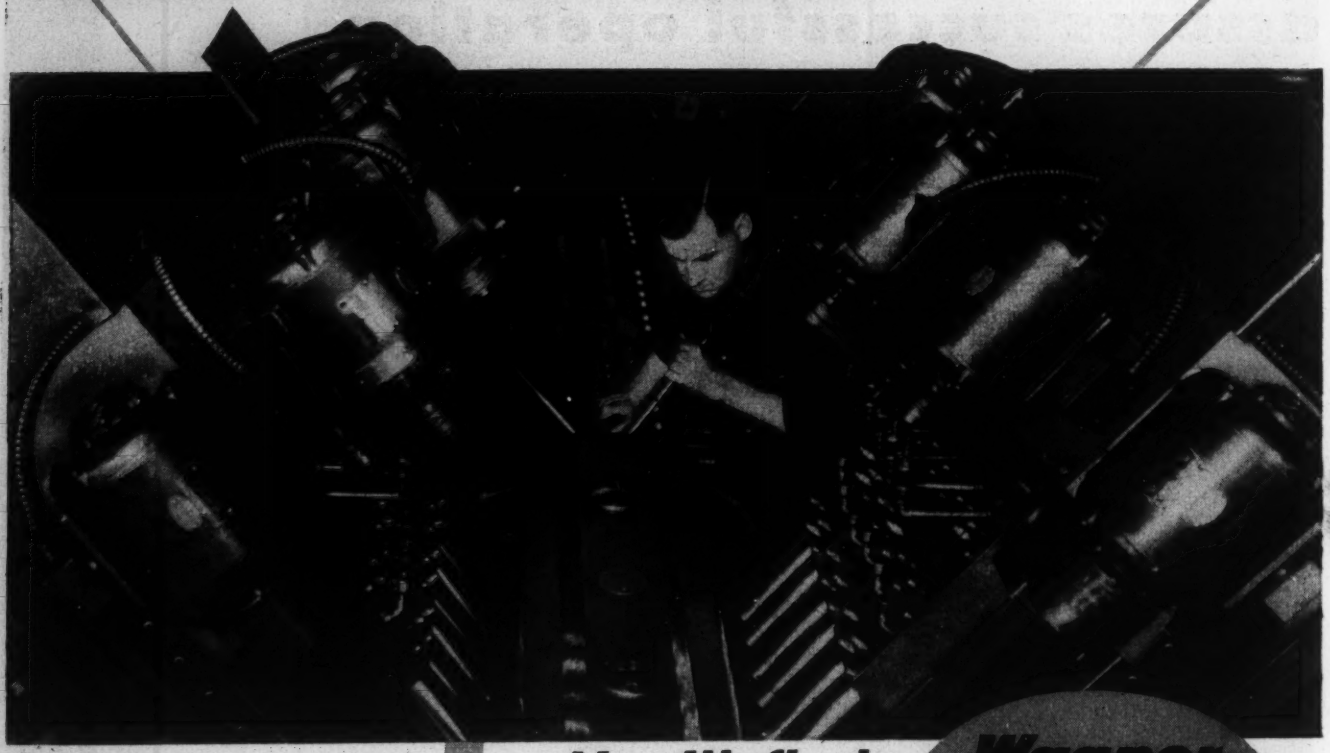
● This is another typically difficult sealing problem that Graphitar is solving in industry today. Graphitar seals seat themselves and form a drop-tight seal under conditions that many conventional seals cannot tolerate. Graphitar *does not warp or distort under heat,* it is corrosion resistant and mechanically strong. Graphitar is a carbon-graphite product that is self-lubricating and extremely light. It can be ground to tolerances as *close as .0005" in small sizes.* Our engineers may be able to suggest Graphitar applications that will improve the efficiency of your products. Send us your prints for recommendations without obligation.

Ask for your copy of the Graphitar catalog.

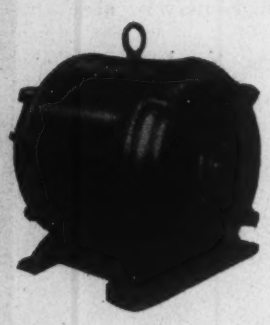
GRAPHITAR

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

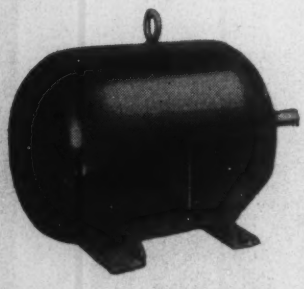
Where PRECISION *Counts...*



You'll find Wagner Motors on the job...



Totally-enclosed Non-ventilated Motor



Totally-enclosed Fan-cooled Motor

Real precision in a machine tool requires motors that operate smoothly, quietly and with minimum vibration. Wagner Motors are noted for these qualities and for long-lived dependability and economical operation as well!

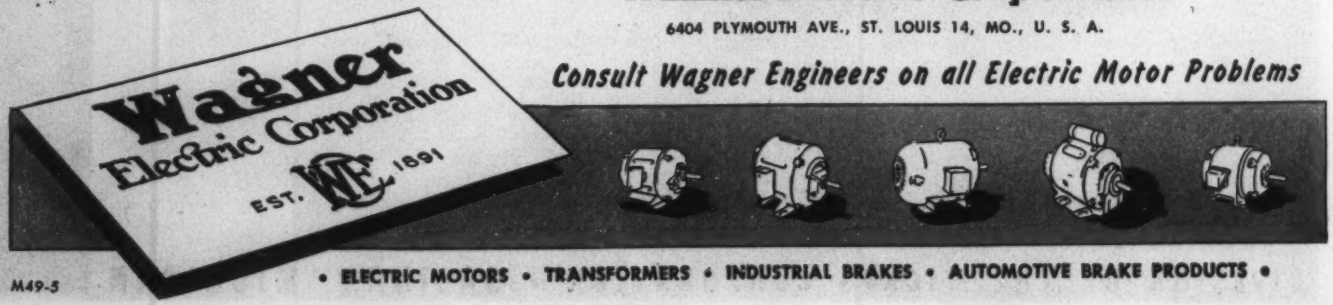
That's why Wagner Motors have been used extensively and are recommended by many widely-known machine tool manufacturers. If you want your machine tools and equipment to operate with precision, and with a minimum of costly "down-time"—choose Wagner Motors, too. Bulletin MU-185 gives information on the complete line of Wagner Motors. Write for a copy.

Buyers of Wagner Motors get Nationwide Service! More than 450 Wagner Authorized Electrical Service Stations and Parts Distributors augmented by 25 Wagner-owned Service Branches are ready to immediately supply on-the-spot service, factory guaranteed exchange motors, or genuine Wagner parts. Write for Bulletin MU-24 for complete list.

Wagner Electric Corporation

6404 PLYMOUTH AVE., ST. LOUIS 14, MO., U. S. A.

Consult Wagner Engineers on all Electric Motor Problems



M49-5

• ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE PRODUCTS •

WHEN FIGHTI[illegible]

no time to [illegible]

IN A FIRE ENGI[illegible]

no space to spare!

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PROVIDE HIGH SPEED, CO[illegible]
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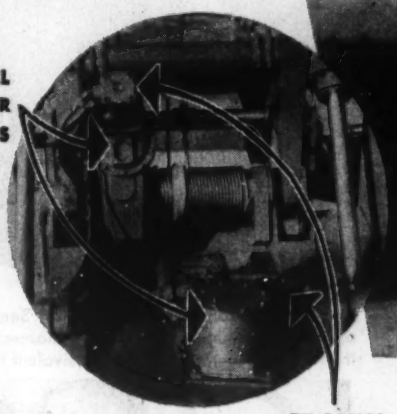

DE LAVAL WORM GEAR REDUCERS

DE LAVAL-IMO PUMPS

Because of their unfailing reliability... small size... high efficiency... high capacity... quiet operation... and smooth pulsation-free power delivery... De Laval-IMO hydraulic motors and worm gear reducers are used by American-La France for operating their large aerial fire towers.

If your equipment also requires quiet, reliable, high capacity pumps, motors and gears...investigate De Laval-IMO pumps, De Laval-IMO hydraulic motors and De Laval worm gears. Write for catalog I-158-D.

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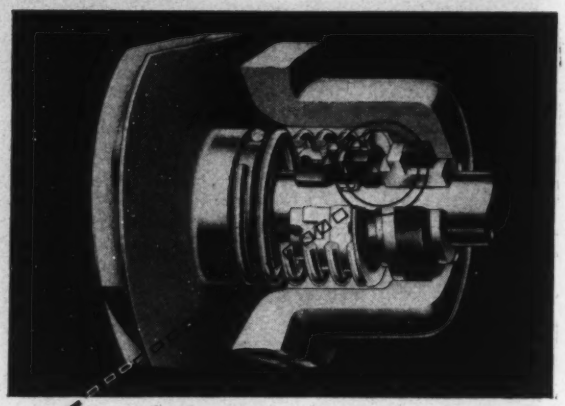
FACTORS IN SHAFT SEAL DESIGN by "JOHN CRANE"

THE REASON WHY PRECISION SURFACES ON MATING FACES ARE IMPORTANT TO SHAFT SEAL OPERATION

Condition of the sealing faces often spells the difference between long life and early failure of the modern mechanical seal. Today's high speeds and pressures make precision-flat mating surfaces a definite necessity for successful seal operation.

Actual sealing in the mechanical seal is performed by two mating faces which are separated by a thin film of lubricant. Uneveness or scratches on either surface create openings which allow foreign particles in the sealed liquid to work in between the faces. Such particles act as abrasives, and by causing excessive wear, result in seal failure. Ordinary machining or grinding forms surfaces which do not keep abrasive particles away from the area between the faces. *Only by precision lapping can surfaces be generated which are flat and smooth enough to form a film of sufficient thinness to exclude them.*

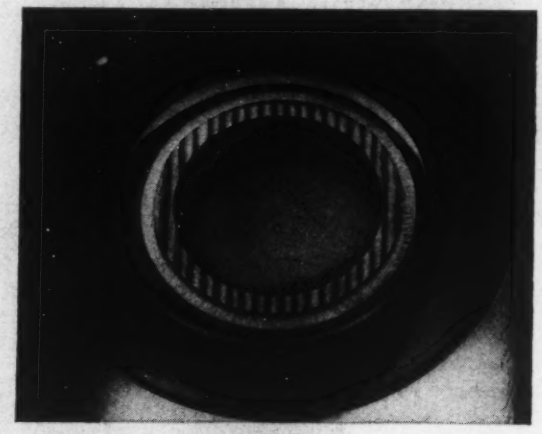


Cut-away view of the "John Crane" Type 2 Shaft Seal. Note, in circle, mating faces of sealing washer and stationary floating seat. Precision lapping to micro-inch specifications and optical flatness requirements insures top performance under high pressures.

TWO OBJECTIVES NECESSARY FOR PERFECT MATING SURFACES

There are two main objectives to be met in the production of a good mating surface, and both can be attained by precision lapping. The first is the removal of surface hills and valleys (scratches and flaws). Measurement of surface finish according to this specification is made in micro-inches, and is an indication of the depth of the valleys and height of the hills of the finished surface. It is known as RMS.

The second objective, extremely important from the mechanical seal standpoint, is flatness of the whole surface area. Such surface measurement is made through optical flats—and in many cases mechanical seal faces must be flat to 11.6 millionth of an inch, which is equivalent to one light band. An idea of the difference between a precision lapped surface and an ordinary ground surface can be gained from the fact that light bands cannot be seen on the relatively rough, ground surfaces.

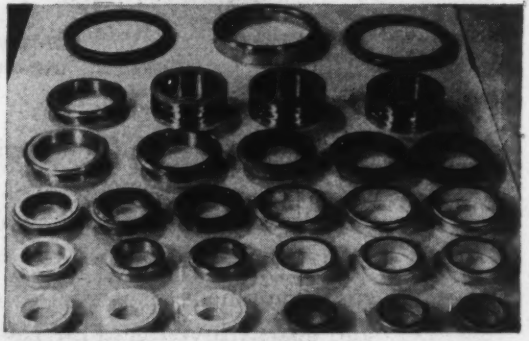


Floating Seat for "John Crane" Shaft Seal, viewed under an optical flat. Light bands indicate flatness measurement less than 11.6 millionth of an inch, equivalent to one light band.

PRECISION LAPPED FINISH FOR ALL JOHN CRANE MECHANICAL SEALS

All sealing washers and floating seats for "John Crane" Shaft Seals are precision lapped on specially developed "John Crane" Lapmaster machines, and are rigidly inspected for both RMS and Optical Flatness Measurement. The precision finish specification for each seal depends on the pressures to be encountered. The higher the pressures, the more rigid is the finish specification.

When you specify a "John Crane" Shaft Seal, you are sure of the finest quality surface finish—of a proper flatness for your application. And, you can also be sure that the Crane Packing Company's wide experience in all types of sealing problems will be at your complete disposal. Contact your nearest Crane Packing Company office the next time a sealing need arises.



Shaft Seal floating seats just lapped by "John Crane" Lapmaster machines. Materials shown include: Stainless Steel, Stellite, Ni-Resist, Bronze, Brass, Cast Iron, Fansteel, Carboloy, Ceramic and Carbon.

Write for the latest free bulletin describing "John Crane" Shaft Seals.

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PACKINGS AND MECHANICAL SEALS

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Can the strength and lightness of Alcoa Forgings put more utility—more *sell* into your products? It's worth investigating. Our staff of forging engineers is at your service, backed by Alcoa's 61 years of light-metal experience. Call your near-by Alcoa Sales Office, or write ALUMINUM COMPANY OF AMERICA, 1940-L Gulf Building, Pittsburgh 19, Pennsylvania.

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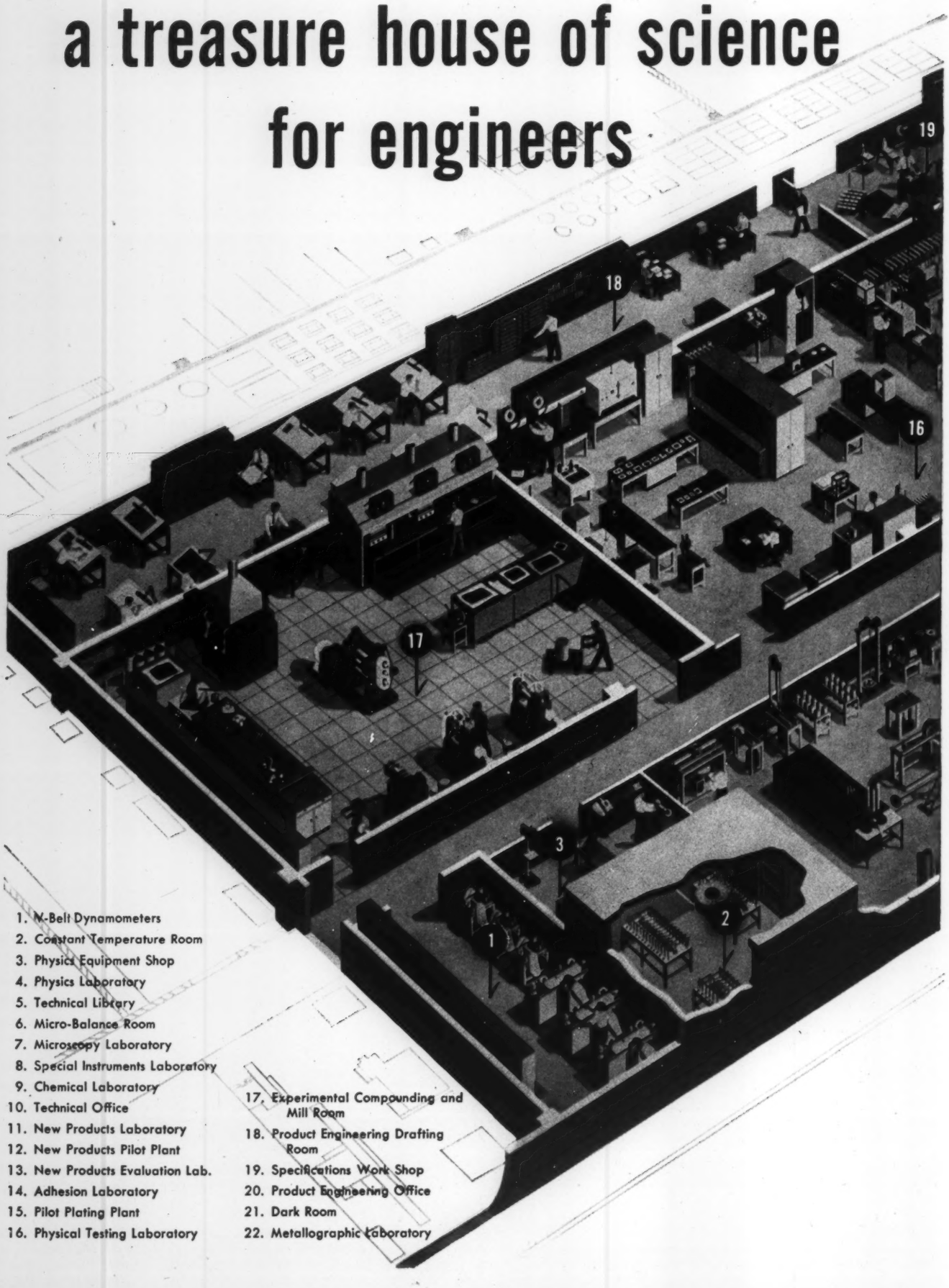

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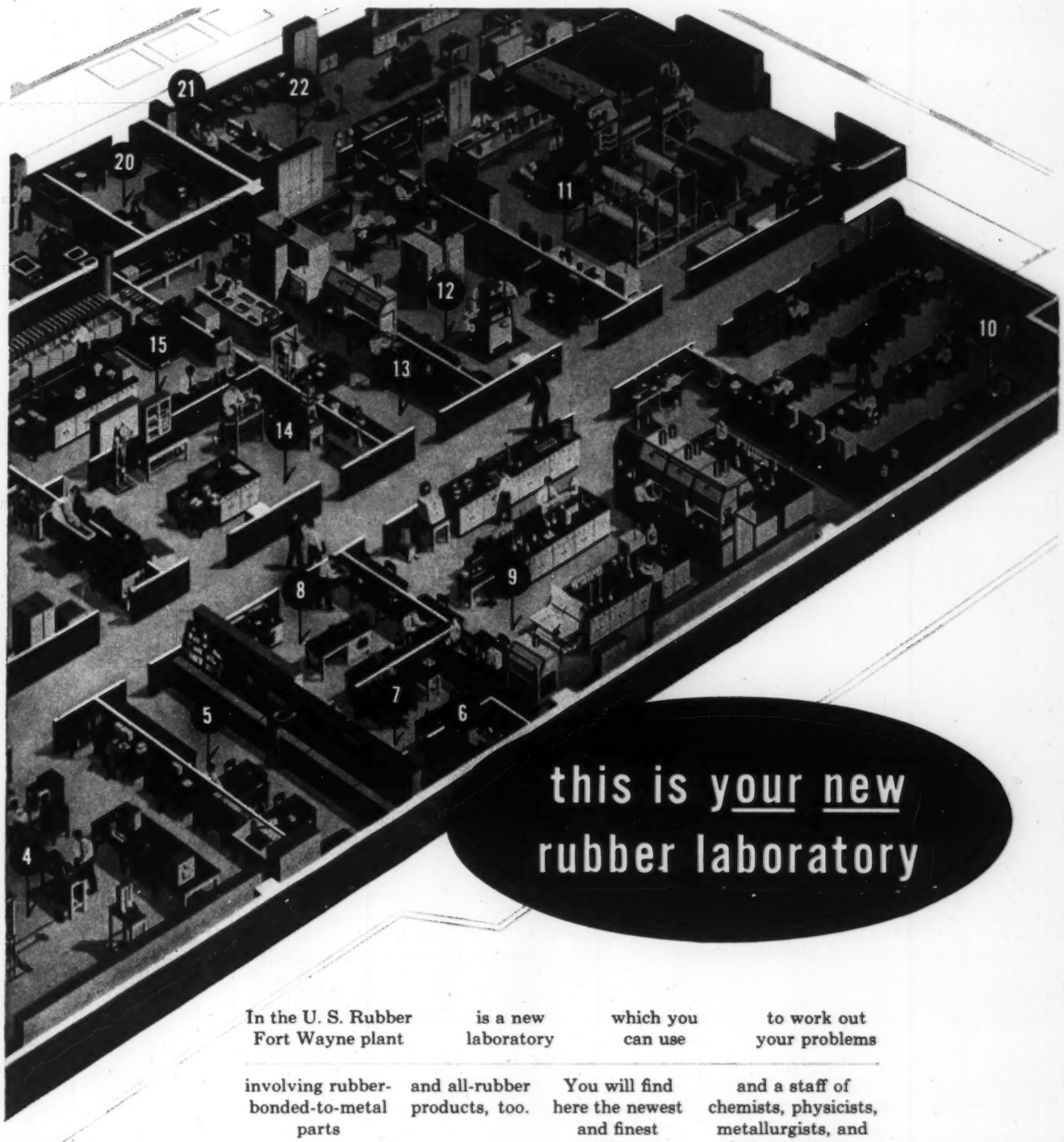

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Complete torquemeter installation for a hydraulic testing laboratory.

HERE—Important New Aids in Product Design and Improvement...

BALDWIN SR-4* TORQUEMETERS

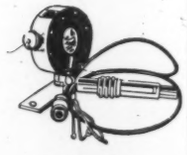
Opening new fields of exact knowledge for the designer, Baldwin SR-4 Torquemeters provide a simple, positive, accurate way of measuring torsional strain with none of the usual errors due to clamping devices, inertia, speed, or vibration. The device consists of a short length of shaft to which a group of special SR-4 Bakelite gages are bonded to form a Wheatstone Bridge. Connections to the recording equipment—which can be located at any desired point—are made through slip rings.

Industry and Research have already utilized SR-4 torquemeters in a number of applications.

HELICOPTER ROTORS AND SHAFTS. Special torquemeter pickups have been developed for determining torque in tail rotor shafts and main rotor shafts during flight, as well as for checks on a test stand.

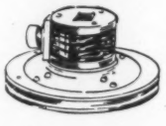
AUTOMOBILE STEERING WHEELS. Steering torque is easily and accurately determined by this unit. A small indicating meter is installed on the instrument panel of the test car.

SCREW DRIVING AND TAPPING. Important production information has been obtained with this torquemeter application, which permits determination of screw driving and tapping torques.



FUEL INJECTION SYSTEMS. Designed to measure vibratory torques in a fuel injection system, this torquemeter pickup has a separately mounted brush assembly.

CENTRIFUGAL PUMPS. The two torque shafts with a single separately-mounted brush assembly, and utilizing a single type T-1 instrument, cover two ranges—350 and 500 foot-pounds—in determining torque in centrifugal pumps.



HAND WHEEL—GUN RAISING. Developed to measure hand-wheel effort in a gun-raising mechanism, this torquemeter is driven by V-belt in rib. Torque is measured on the spokes.

Baldwin Torquemeters have been built for shafts from ¼ to 18 inches diameter, in capacities from 1 in. lbs. up to 750,000 in. lbs., and for speeds from zero to 10,000 rpm and above. General principles of construction and operation are covered in Bulletin 275, sent on request. A Baldwin representative will gladly discuss your torque-measuring problems with you, and suggest the proper unit to meet your needs.

The Baldwin Locomotive Works, Philadelphia 42, Pa., U. S. A. Offices: Boston, Chicago, Cleveland, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Seattle, St. Louis, Washington. In Canada: Peacock Bros., Ltd., Montreal, Quebec.

*T. M. Registered U.S. Pat. Off.

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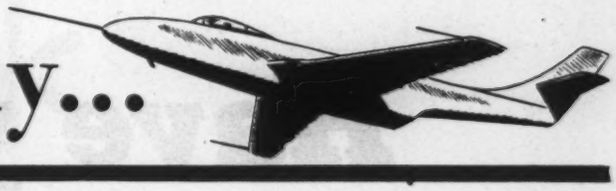
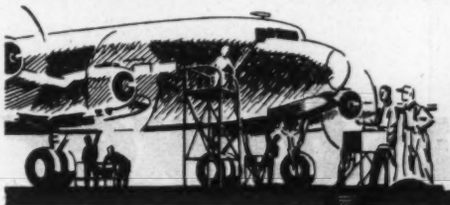
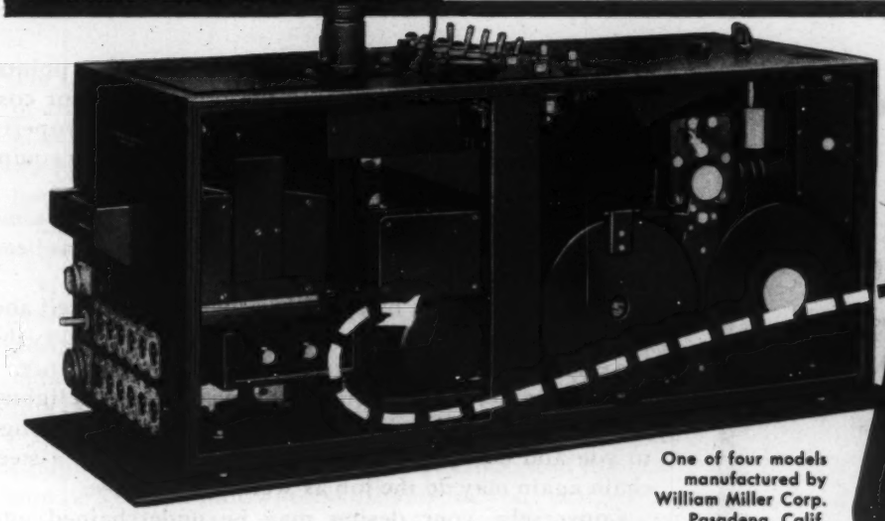
TESTING HEADQUARTERS **BALDWIN**

eye in the sky...

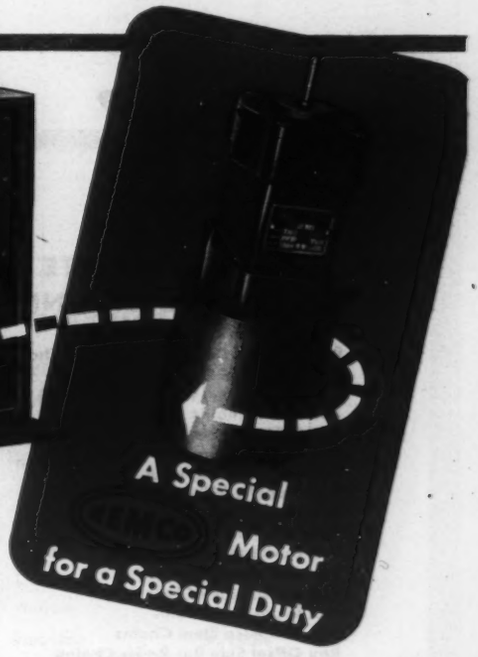


ear to the ground





One of four models manufactured by William Miller Corp. Pasadena, Calif.



This EEMCo powered recording oscillograph serves as mechanical eyes and ears for aircraft flight and ground tests

The record traced by this Miller oscillograph during flight, taxiing, and ground tests reveals the secrets of performance. Serving as multiple "eyes and ears," this equipment records data on vibration, temperature, stress, strain, and other factors. Telling "the unvarnished truth," it guides aircraft builders in elimination of "bugs" in new designs, and provides invaluable data for re-design and preparation of new designs.

Operating methods of this machine demand special and severe motor requirements. Space limitations do not permit use of a conventional motor. EEMCO met these demands with a compact, versatile motor for operation. on 6, 12 or 24 volts d.c., and 110 volts a.c. or d.c., with 50 watts output at 3000 r.p.m. It is governor controlled, with plus or minus 1% speed variation. The EEMCO motor's superior starting torque for quick starts, and its constant speed, assure complete, faithful recording. Here is a typical example of *desired results delivered* when the problem is put up to EEMCO.

Write us about your motor requirements

We invite correspondence, without obligation, for preliminary study of any current electric drive problem you may have.

Motor design problems of manufacturers in widely varying fields have been solved by our engineers. Our specialty is tough problems of function, power, size, weight, shape, performance, installation, and operation.

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THE COMPLETE CHAIN BELT LINE

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Rex Offset Side Bar Roller Chains
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Rex Drop Forged Chains
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Rex Cast Sprockets
Baldwin-Rex Cut Tooth Sprockets
Baldwin-Rex Flexible Coupling
and a complete line of chain attachments.

If you're designing for lower costs, consider these points. Have you thoroughly explored the possibilities for cost reduction and improved performance offered by properly applied power transmission, timing, and conveying equipment?

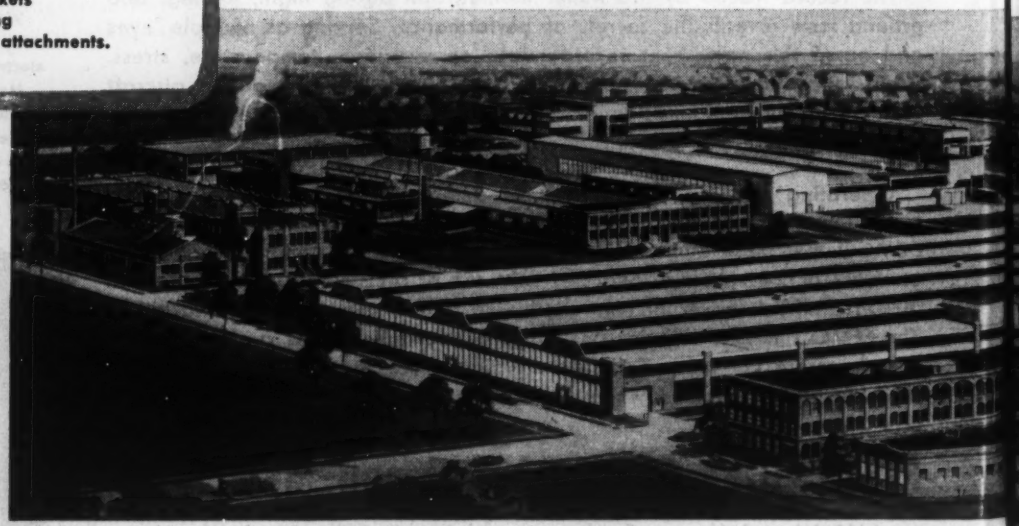
Perhaps you're using the same basic design . . . the same type equipment for these important functions that has been used for years.

Maybe it's still the best, but you owe it to yourself and your customer to be sure that the product you use is the lowest in cost, consistent with quality and performance.

For example, your design may be overchained. A lighter chain may do the job just as well with important savings to you and the customer. A cast chain instead of a steel chain again may do the job as well at lower cost.

Conversely, your design may be underchained and liable to premature breakdown, resulting in far greater overall cost to you and your customer.

Perhaps you are using other methods of transmitting power or timing operations and a chain drive can effect substantial savings in space, costs and weight.



CHAIN BELT REX COMPANY

CHAIN BELT COMPANY

HERE* costs?

There is no one best or stock answer to the problem of transmitting power, timing operations or conveying materials. That is why we at Chain Belt Company feel that we can be of practical assistance to you in designing for lower cost. Because we manufacture a *complete line of chains,* both cast and steel, we can help you select the chain that is exactly right for your machines.

If the operating conditions are such that a cast chain is indicated, we have the exact chain that will best fit the need. Where speeds and horsepower requirements demand a finished steel roller chain, again our complete line contains the answer.

Our Field Engineers plus our Plant Engineers are well equipped to work with you in the selection and application of Rex and Baldwin-Rex Chains for your designs. In many instances they have been able to help effect substantial savings and increase machine efficiency through the flexibility of our complete line and their years of practical experience. Call or write the Chain Belt Company Field Office near you or write direct to Chain Belt Company, 1643 West Bruce Street, Milwaukee 4, Wis.

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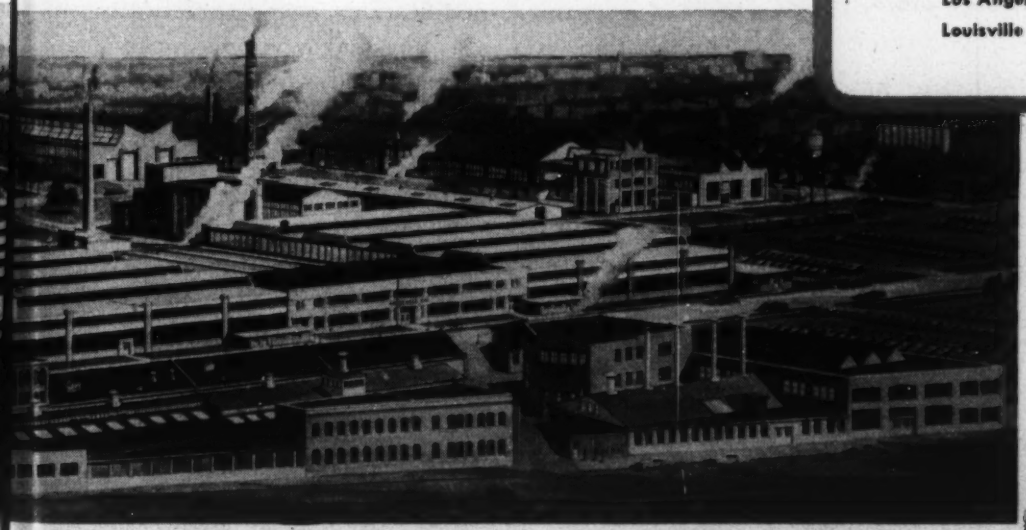

Here is a composite view of Chain Belt Company's manufacturing facilities. From these plants comes a line of chains unsurpassed for completeness . . . chains that have been serving industry everywhere for over 50 years.

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Milwaukee 4, Wisconsin

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NEW ADDITION

CROCKER-WHEELER MADE MOTOR NEWS THEN . . .

1894 . . . *the first electrified printing plant in the world* is installed (for the New York Life Insurance Company) by Crocker-Wheeler. Soon C-W motors were in use in the Government Printing Office in Washington, the Bureau of Printing and Engraving, the United States mint in Philadelphia. This early Crocker-Wheeler driven machinery was to be the forerunner of the modern high speed printing press.

and CROCKER-WHEELER IS MAKING MOTOR NEWS *today*

C-W WOUND-ROTOR MOTORS

From 1 to 2000 hp.

Now Crocker-Wheeler brings you a streamlined Protected-Type WOUND-ROTOR Motor with all the up-to-the-minute advantages of the popular C-W Protected-Type Squirrel-Cage Induction Motors.

Users of C-W Protected-Type Squirrel-Cage Motors know well the advantages of Crocker-Wheeler design . . . and the many mechanical modifications which make these standard motors so versatile. Now the *same* advantages are available in wound-rotor motors.

For printing, conveying, ventilation and other services that require smooth acceleration, high starting torque with low starting current, ability to start and stop or reverse frequently, or variable speed, these new C-W motors will provide unexcelled performance.

Sizes from 1 to 2000 h.p., and an exceptionally wide choice of mechanical modifications, answer practically all application problems. You may have splash-proof and totally-enclosed non-ventilated, as well as the protected-type design. Choose from vertical, NEMA D flange or C face mountings and all standard NEMA floor, or ceiling mounting assemblies. Special windings are available for crane and hoist duty.•

The excellence and motor know-how built into C-W Wound-Rotor Motors is clearly explained in the new Bulletin SL-330-1. Mail coupon for your copy. *Now.*

Protected-Type Induction Motors Vertical or Horizontal

Totally-enclosed, fan-cooled Motors

A-C Generators and High Speed Synchronous Motors

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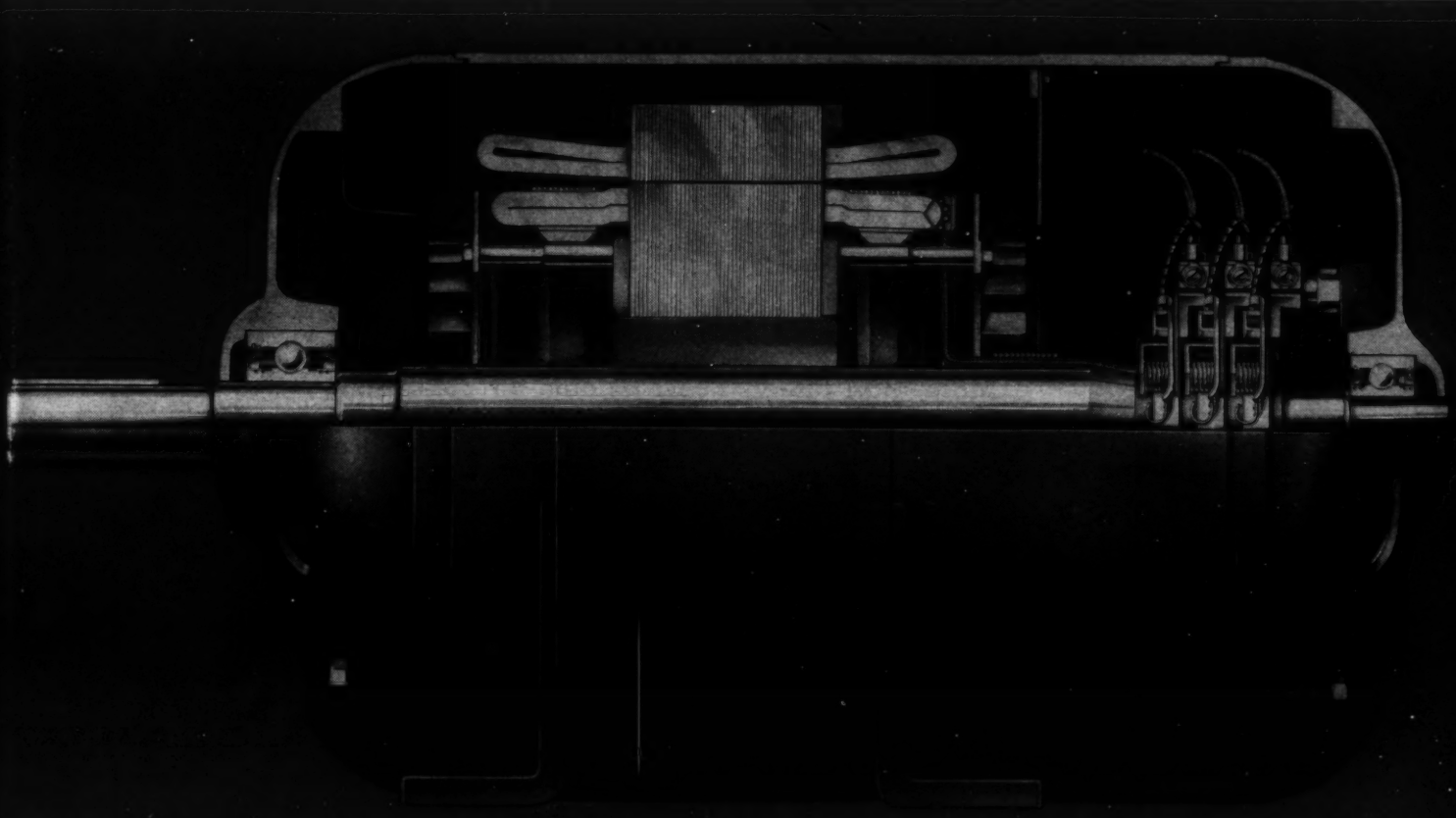

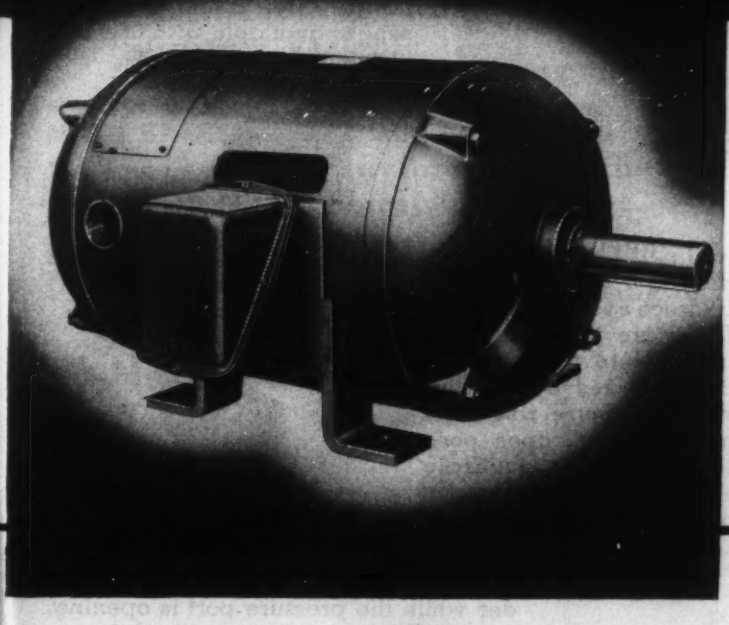

Better Built because---

Frames and endshields dripproof—keeps dripping liquids and falling chips out of windings.

Louvered openings on both sides of frame for maximum cooling, with effective protection.

Air guides distribute cooling air effectively.

Stator and rotor coils of vinylacetal insulated wire, protected by thoroughly-baked thermosetting varnish for maximum rigidity and long-lasting protection against electrical failure.

Slip rings cast of special composition bronze for long life, mounted on steel hub, insulated from hub by mica sleeve.

NEMA frames 364-505 have heavy rolled steel frame for strength. Sturdy welded feet.

Full details of the many other fine points of these motors are included in the new Bulletin now available. Send coupon.

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Ampere 3, N. J.

Please send new Bulletin SL-330-1, describing Crocker-Wheeler Protected-Type Wound-Rotor Motors.

MD-1149

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Title or Function_____

Company_____

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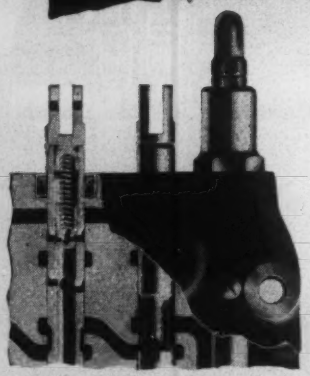
DO YOU USE OIL-HYDRAULICS?

...then check these features of HYDRECO HOLLOW PLUNGER* VALVES



Specifically designed for oil-hydraulic systems.

More than fifteen basic models for controlling one or more single and double-acting cylinders.

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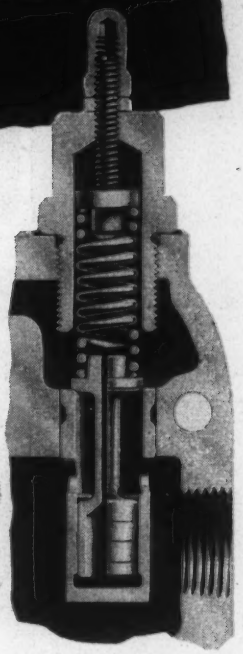
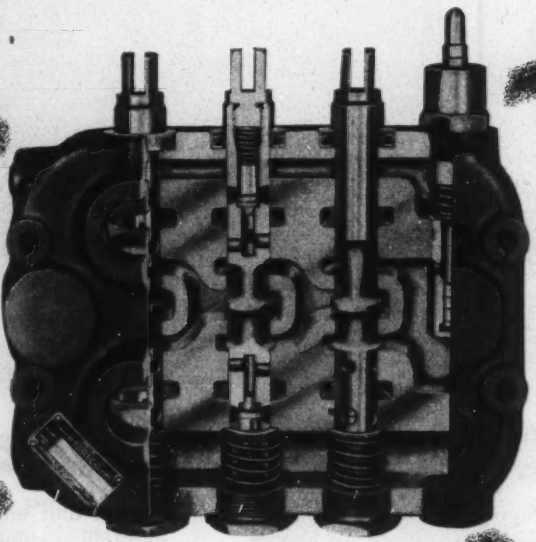


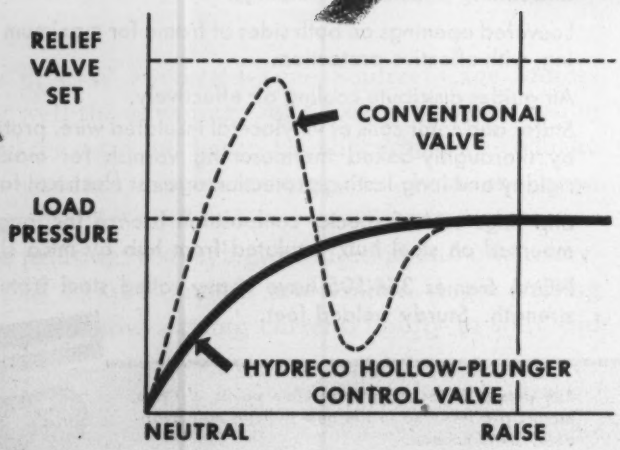


HOLLOW-PLUNGER* DESIGN

Check valves built-in to reduce mounting space. Staggered circular port openings for better throttling. Even pressure around plunger cuts out hydraulic locks. Plungers individually selected and hand fitted.

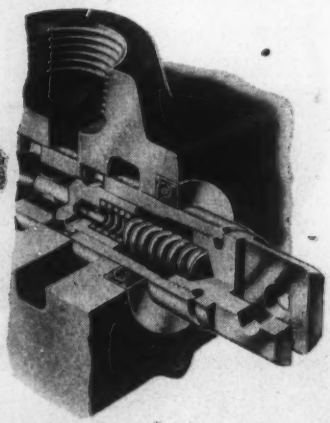
DIFFERENTIAL RELIEF VALVE

Cuts out relief valve noise and chatter. Light and low stressed springs used. Smoother operation, quicker opening and longer life. Four pressure ranges available with fine adjustment in each range.



OPERATION

Here is a graphic view of Hydreco's valve operation. There are no dead spots, no pressure peaks in Hydreco valves but a constant pressure rise from neutral to full open position. You get accurate throttling and smooth, quick action.



BUILT-IN CHECKS

Prevent any pressure drop in the cylinder while the pressure port is opening, as cylinder pressure is held while operating positions are changed. Momentary load drop is entirely eliminated.

Hollow-Plunger Design protected by existing U.S. and Foreign patents as well as patents applied for.

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SPEED RANGE zero to maximum 4:1 ratio is infinitely variable through simple control.

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INSTANT RESPONSE to speed changes which can be made either while operating or stopped.

MOUNTS IN ANY POSITION because it operates up-side-down, sideways or any way making it easy to incorporate in design of any product requiring variable speed.

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ONLY **$12.95** FACTORY

Internal Mechanism as illustrated above

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Company.....
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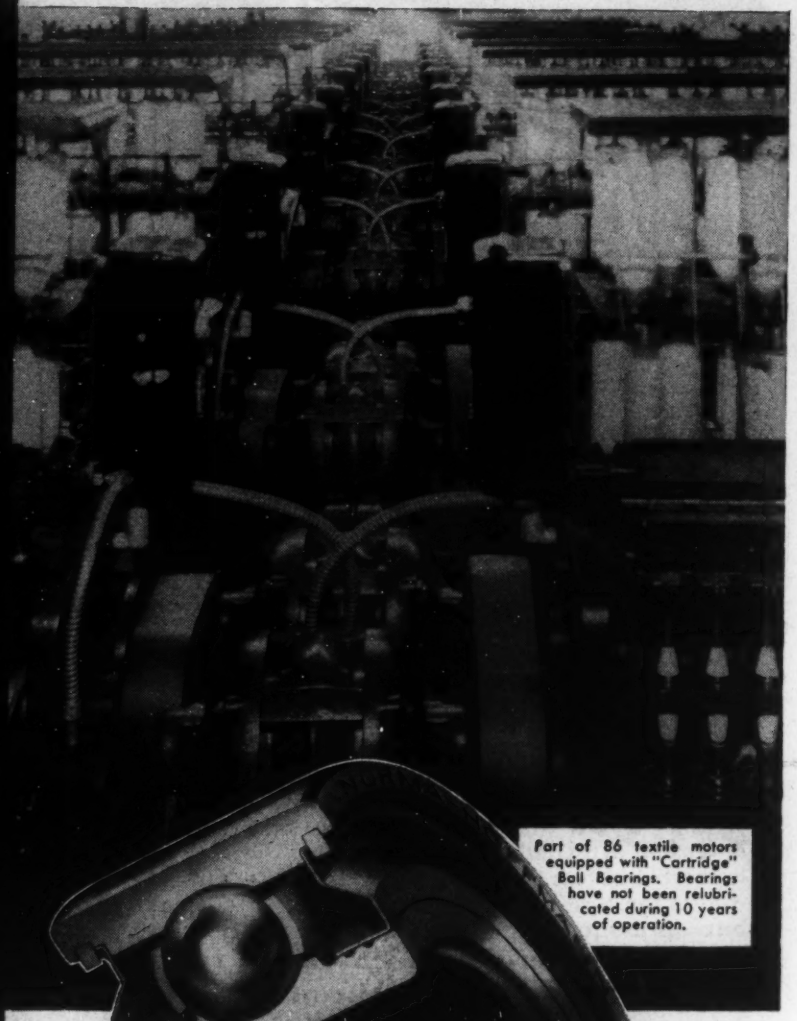
City..... Zone.... State.....

CASE HISTORY #819

646 Motors Operate 8 to 10 Years Without Relubrication or Bearing Failures ...and they're still going strong



Part of 86 textile motors equipped with "Cartridge" Ball Bearings. Bearings have not been relubricated during 10 years of operation.

Norma-Hoffmann

Patented "Cartridge" Bearings increase the "Life-Span" of Equipment

Records prove that Norma-Hoffmann "Cartridge" ball bearings give continuous performance in hundreds of applications without failure.

For example — 646 motors in 5 textile mills have been operating practically continuously for 8 to 10 years without relubrication. On inspection of many of the motors, the bearings showed no appreciable wear and the original grease was in good condition for many more years of operation.

Made to double-row width, Norma-Hoffmann "Cartridge" bearings have 100% more grease capacity than conventional width sealed bearings. The highly efficient seals keep dirt out, grease in. Factory-packed with Norma-Hoffmann's specially compounded "stability-tested" grease . . . grease that is highly resistant to oxidation and breakdown . . . assures dependable operation for long periods without regreasing.

Investigate the "Cartridge" ball bearing for your products whether they be motors, machine tools, pumps or other machinery. Our engineers are always available for consultation about your bearing applications. Write for their services.

NORMA-HOFFMANN *Precision* **BEARINGS**

BALL • ROLLER • THRUST

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It takes 1,568,586 loops (AND FORTY MINUTES) to make a single 51-gauge stocking

High-Production Full-Fashioned Knitting Machines, 52'9" long and capable of knitting thirty stocking blanks simultaneously, are produced by the Textile Machine Works, Reading, Pa. With a total of 14,280 needles, each of its thirty sections lays a course of 476 loops in less than a second . . . yet it takes close to forty minutes to knit the one-and-a-half million loops required for a single 51-gauge stocking blank.

With so many moving parts, it wasn't easy to obtain the necessary smoothness of operation at high speeds. Precision, balance and long-wearing-and-bearing qualities had to be built into each of the machine's components—420 of which are made of twelve different Anaconda Extruded and Drawn Brass Shapes.

These shapes, made of wrought metal, are tough, strong, dense-grained and smooth-surfaced, with cutting characteristics that make them ideal for such precision-machined parts as those illustrated below. Besides, these parts are now being produced at a saving of 25 to 30% over the cast-brass sections they replaced.

The cost-paring advantages of Anaconda Extruded and Drawn Shapes are not limited to the textile industry. Produced in copper, brass, bronze or special copper alloys, they are available in an infinite variety of cross-sections. For further information, write to The American Brass Company, General Offices: Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 49109

There's nothing skin-deep about the beauty of this lamp

Too bad we don't have X-ray eyes . . . we'd be spared the disappointment of learning, too late, that the things we thought were solid brass—are not.

Not so with the "China-Brass" lamp illustrated above. It's typical of the entire line of solid brass table lamps, floor lamps, and smokers made by the Oxford Metal Spinning Co., Inc. of Philadelphia, one of the country's foremost lamp designers and manufacturers.

As a purchaser, you'd be well pleased with its handcrafted beauty—the durability of its solid brass construction—and, of course, its moderate price.

As its manufacturer, you'd quickly recognize the economy of using solid brass for its metal components. For in this plant—which annually produces hundreds of *different* patterns, shapes, and designs —not a single stamping or drawing die can be found. Instead, coils of Anaconda Spinning Brass are sheared to squares, centerpunched, cut to circles, and spun by hand. In this way, several hundred duplicates of an original design can be completed before a toolmaker could get halfway through a set of dies. Savings are passed on to the customer.

Using brass of just the right composition, grain size and temper is an important part of this low-cost, high-quality program. That's why "Oxford" consistently specifies "Anaconda Brass"—made by The American Brass Company, General Offices, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Limited, New Toronto, Ontario.

NEW C-D Silicone Dilecto withstands an inferno of heat and electricity

to improve product performance for you!

There are three new grades of C-D Dilecto* that can withstand temperatures as high as 250°C. They are chemically inert, silicone-glass laminated plastics that offer exceptionally high heat resistance and good arc resistance, extra strength, and positive moisture resistance! At Continental-Diamond we've literally lived and worked with Silicone Dilecto—perfecting it to a point where we believe it can be highly useful in helping to solve your production problems — and improve product performance.

And this remarkable plastic is but one of many in the C-D family. They provide practical combinations of mechanical, electrical, and chemical properties—structural strength, light weight, positive moisture, heat and corrosion resistance. In hundreds of plants, C-D Plastics—Fibre, Vulcoid, Dilecto, Celoron, and Micabond—offer proof that it pays to see C-D first in your search for the right plastic for the job. For interesting, useful information on Silicone Dilecto, and other C-D high strength plastics, call or write your nearest C-D office, soon.

your partner in producing better products

*Dilecto GB—112—S
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DE-2-49

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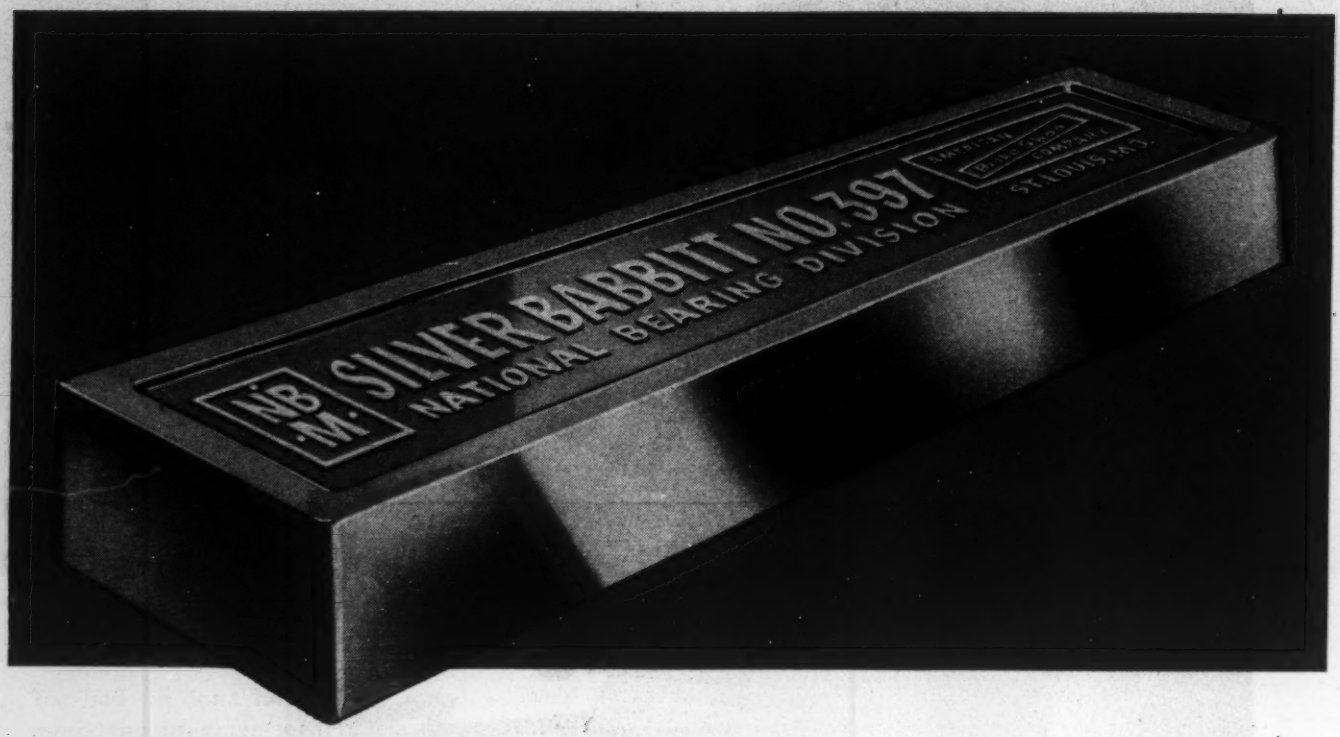

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N-B-M No. 397 SILVER BABBITT

Yes, if you are interested in lowering costs of your plant operation or product, investigate N-B-M No. 397 Silver Babbitt.

You will find, *first*, that N-B-M Silver Babbitt costs from 30% to 40% less per pound than tin-base babbitt, and *second*, that it has all of tin-base babbitt's good performance characteristics:

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- **Has high corrosion resistance**
- **Embeds dirt and grit, even at room temperature**

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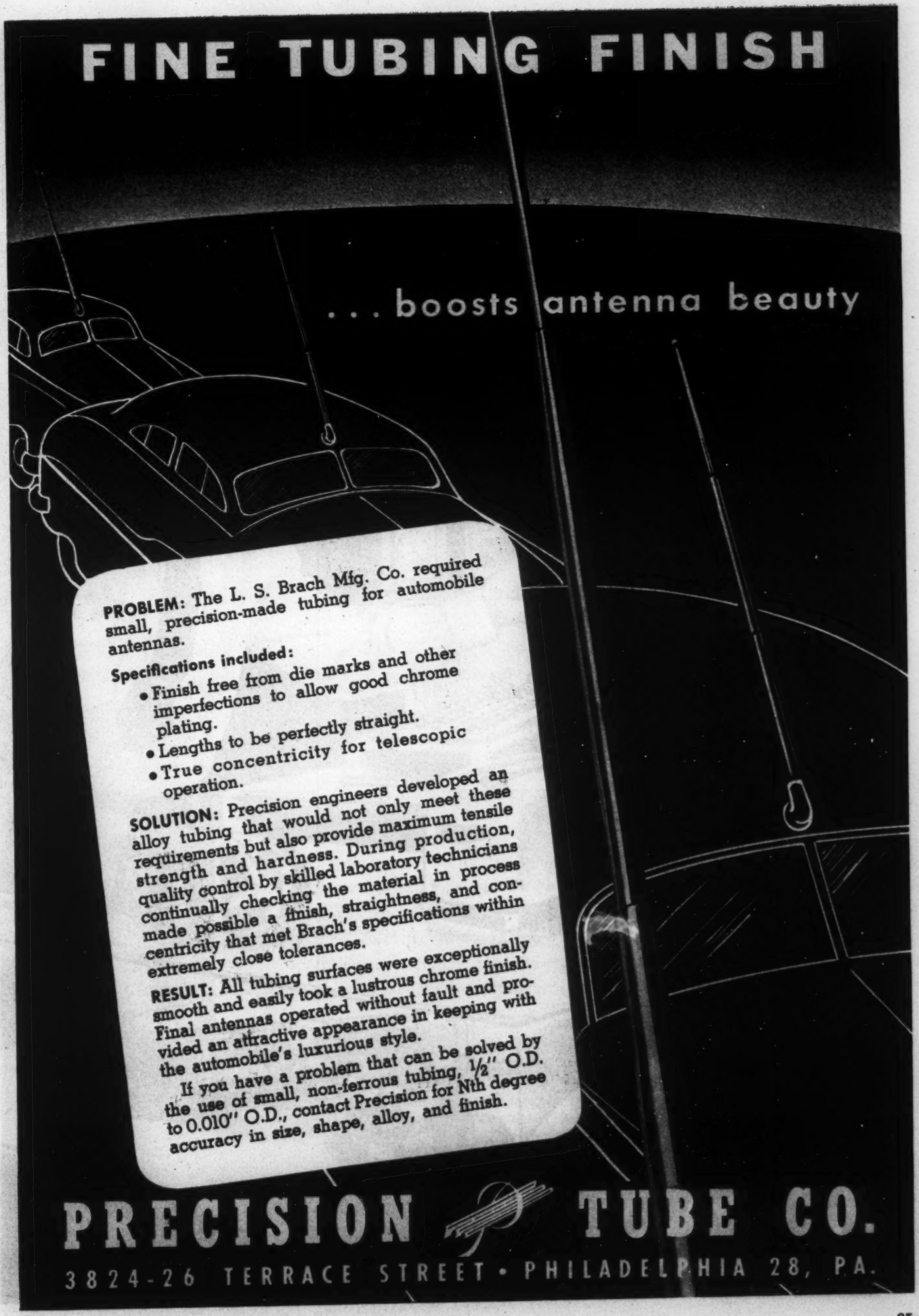
FINE TUBING FINISH

. . . boosts antenna beauty



PROBLEM: The L. S. Brach Mfg. Co. required small, precision-made tubing for automobile antennas.

Specifications included:

- Finish free from die marks and other imperfections to allow good chrome plating.
- Lengths to be perfectly straight.
- True concentricity for telescopic operation.

SOLUTION: Precision engineers developed an alloy tubing that would not only meet these requirements but also provide maximum tensile strength and hardness. During production, quality control by skilled laboratory technicians continually checking the material in process made possible a finish, straightness, and concentricity that met Brach's specifications within extremely close tolerances.

RESULT: All tubing surfaces were exceptionally smooth and easily took a lustrous chrome finish. Final antennas operated without fault and provided an attractive appearance in keeping with the automobile's luxurious style.

If you have a problem that can be solved by the use of small, non-ferrous tubing, 1/2" O.D. to 0.010" O.D., contact Precision for Nth degree accuracy in size, shape, alloy, and finish.

PRECISION TUBE CO.

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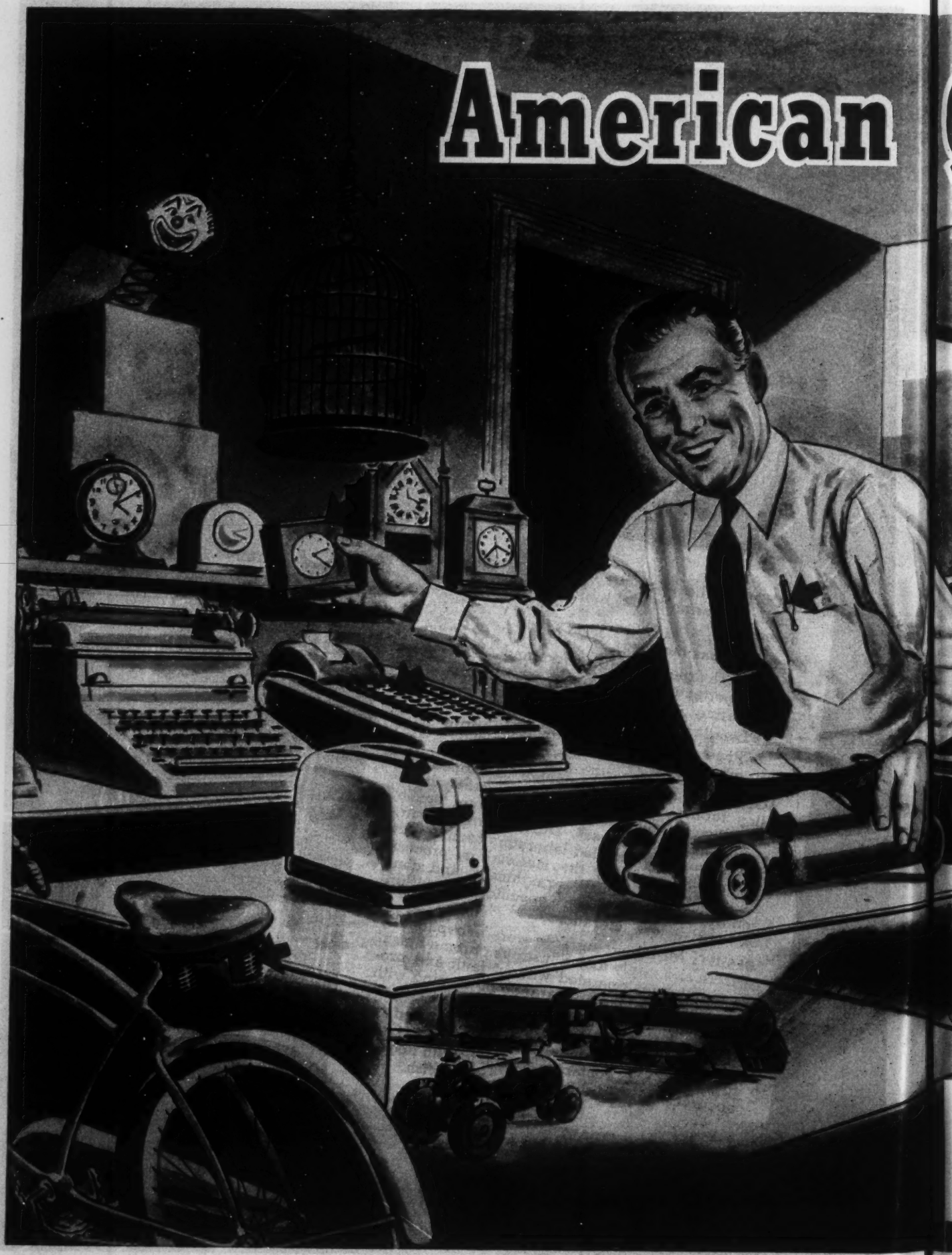
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Quality Springs

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Performance insurance"

into any product!

● The ever-swelling tonnages of springs being shipped out of our mills . . . the enthusiastic comments our salesmen and engineers are receiving from all quarters on the performance of these springs, are hard and fast proof of this fact:

American Quality Springs are one of the best forms of "performance insurance" you can possibly give your product!

Just 30 minutes spent in one of our spring mills would convince *any* spring user that he could place complete confidence in our American Quality Springs. For he'd see machinery and facilities that are generally regarded as the finest in the industry. He'd witness the skilled work of some of the best spring and wire men in the country. And he'd see the over-all efficiency which is characteristic of all of our wire product operations.

Our engineers know springs. They're ready to tackle *your* problem. Why not get in touch with us *soon?*

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USS **AMERICAN QUALITY SPRINGS**

UNITED STATES STEEL

TOPICS

PNEUMATICALLY CONTROLLED plane, using power from turboprop or auxiliary turbine engines, is a future possibility, according to H. J. Wood and F. Dallenbach of AiResearch Manufacturing Co. Using compressed air from the main propulsion engines for the auxiliary controls will make possible substantial design simplification and reduction of weight.

WELDING of chrome-nickel stainless steels, aluminum, and aluminum bronzes is performed at high speeds by the Aircomatic or inert-gas shielded metallic arc welding process developed by Air Reduction Sales Co. In welding stainless the filler metal is carried across the arc and deposited virtually without loss of alloying elements.

PHOTO-GRIDS used for studying the flow of metal in forming operations, provide more accurate measurements through a new method of producing finer line screens and better quality lines on the photographic grid which is produced on the surface of the material. These lines are 0.015-mm wide and spaced 0.25-mm apart.

PLASTIC OPTICAL LENS with stable and accurate aspheric optical surfaces corrected for binocular viewing have been announced by Imperial Chemical Industries Limited. Allowing a larger field of view, the lens is free from distortion at the edges.

ACTINIUM, a rare radioactive element is being produced industrially, according to an announcement by Boris Pregel, president of International Rare Metals Refinery Inc. Last of the natural radioactive elements to be isolated in commercial quantities, actinium is about 150 times as active as radium, making it of value to nuclear physicists in the production of neutrons.

SWAMP GLIDER, with a three-man crew, can travel through muck-filled water at 15 mph. Developed by the Air Materiel Command, it is powered by a 95-hp marine engine augmented by a pancake type centrifugal hydrojet propulsion unit. When converted to a fire boat it is capable of pumping 1650 gallons of water a minute at 85 pounds head pressure.

CUT-WIRE SHOT improves peening operations on automotive chassis springs both with respect to better quality and lower cost. Fatigue life of the springs is more than double that for springs peened with chilled cast-iron shot, fatigue life being better than 1,000,000 cycles, according to H. H. Miller, General Motors Corp. Cut-wire shot is made from MB hard-drawn mechanical spring wire and cut into lengths equal to the diameter.

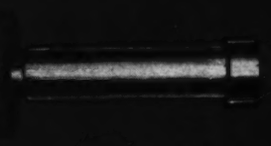
RUBBER PARTS may now be manufactured in every color of the rainbow as a result of the development of a fine silica pigment, particle size being 0.025-micron. Known as Hi-Sil and developed by the Pittsburgh Plate Glass Co., the pigment is said to impart high tensile strength, good abrasion resistance and exceptional tear resistance to natural and synthetic rubber compounds.

BATTERIES with exceptional capacity have been developed by Willard Storage Battery Co. to crank engines of vehicles in temperatures as low as −65 F. Battery plates are produced from a vaporized lead oxide and are exceptionally thin, permitting the use of many additional plates and providing a corresponding increase in the plate area exposed to the action of the battery acid.

NEW INDUSTRIAL MINERAL, wollastonite, has been demonstrated to be useful as a component for thermal insulation and other commercial and industrial uses. Occurring in substantial deposits in New York, the mineral has a wide range of possibilities, according to a report based on pilot-plant studies and released by the Office of Technical Services, Department of Commerce.

GAS TURBINES for automobiles will be cheaper, smaller and lighter than the present auto engines. Frank L. Schwartz, in addressing a recent ASME meeting, said other advantages will include fewer moving parts, low oil consumption, no need for antifreeze, smooth operation, elimination of automatic transmissions and ability to use low-grade fuels.

WHICH ONE? NAME YOUR SPINDLE

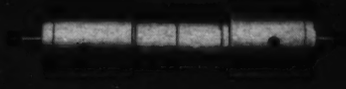


P-1

P-32T

P-2500

INTERNAL



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No. 62

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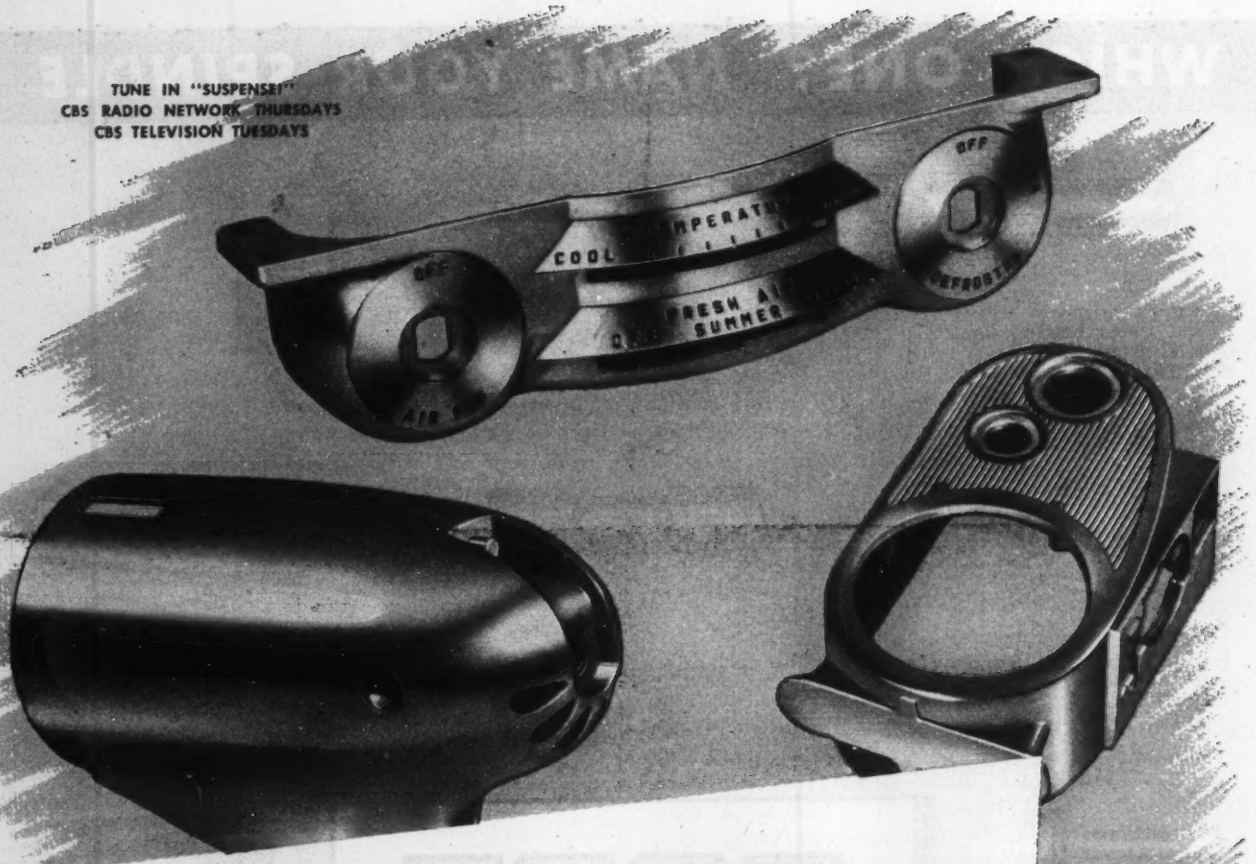

AUTO-LITE

DIE CASTINGS

● Increased production facilities for die castings made possible through the famous Auto-Lite "controlled metals" processes are now available. The opening of the great new Lockland plant of Auto-Lite, combined with the enlarged facilities at Woodstock, Illinois, greatly increases Auto-Lite's ability to furnish high quality die castings.

AUTO-LITE MEANS PRECISION MANUFACTURING

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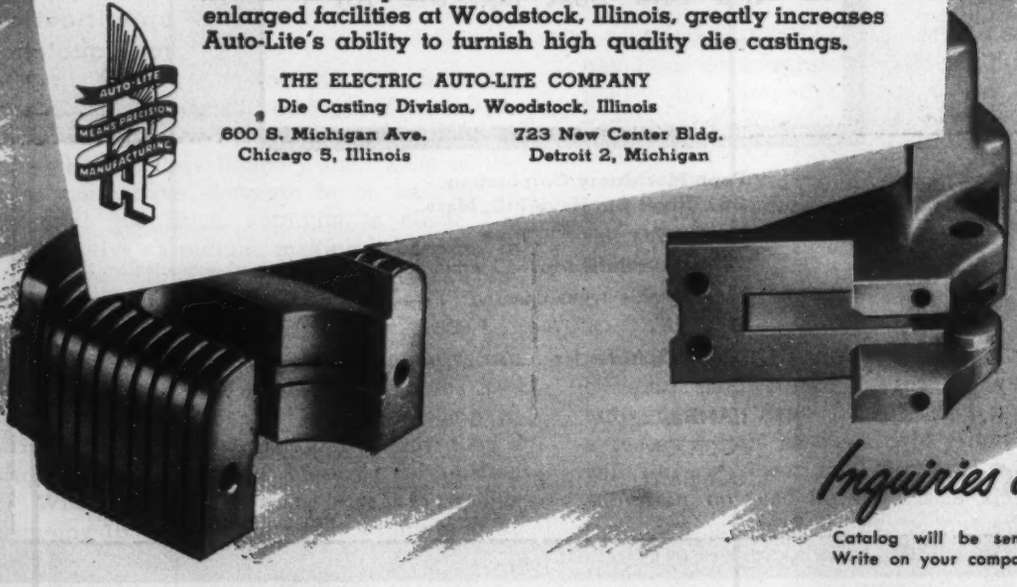

Inquiries invited

Catalog will be sent on request.
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MACHINE DESIGN
A PENTON PUBLICATION

Attitude—Neglected Key to Reduced Costs

A GREAT deal is being written and said about the designer's obligation to create machines which can be produced at lowest possible cost compatible with adequate quality. Generally, we think of this obligation in terms of such factors as design simplification, more judicious selection and utilization of materials, and better understanding of the processes of production. These are the means available to the designer in keeping costs at rock-bottom levels—if he wants to.

These four words—if he wants to—sum up the one big factor upon which all other factors depend if a continuing cost-pruning design program is to be fully effective. Few of us are incapable of doing better work—if we want to. In other words, it depends on our attitude. The designer who sees his job as little more than a satisfactory source of income cannot possibly do his best. He lacks enthusiasm—has no real desire to extend himself beyond what he considers to be acceptable, run-of-the-mill performance.

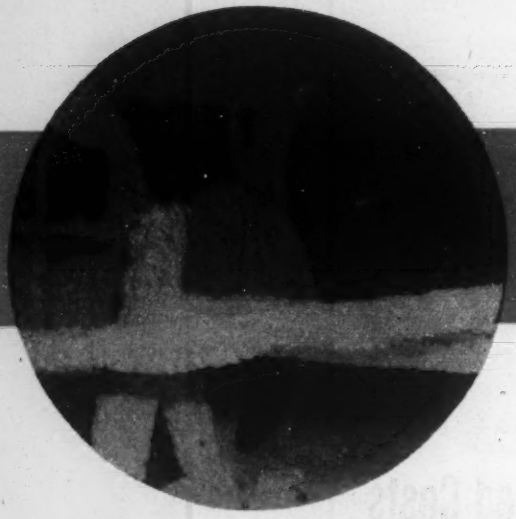
Here is a great challenge to engineering management; for it can, if it will, engender in design personnel the high morale so essential to outstanding performance. If costs are to be cut to the bone, the designer must understand and fully appreciate why. Further, he must be firmly convinced of the necessity and rightness of such a program.

Management can bring this about by imparting to designers in open, frank discussions an understanding of the "business end" of business. Such discussions would acquaint the designer with what happens to his designs after they leave his board, how they are sold, for how much, where the money goes, and with whom and how they compete—always with emphasis on the reasons why.

The role of the designer in America's great economic venture is vital, for he exerts a tremendous influence on putting more goods into the hands of more people at lower costs. Sell him the validity and rightness of low cost and he'll do his whole-hearted, co-operative best. Further than that, he'll be a better citizen and a more enthusiastic proponent of the American way.

Richard L. Lozier

ASSOCIATE EDITOR



Subzero Lubrication

An authoritative discussion of the key factors involved in lubricant selection and designing for subzero lubrication

ADEQUATE lubrication of bearings which must operate at subzero temperatures has become increasingly important in many of today's engineering applications. The designer, even more than the user, of equipment subject to low-temperature conditions must meet and solve the attendant problems. Too often, in the past, lubrication problems have had to be met and solved after the apparatus was designed and built. Knowledge of the performance he can expect from available lubricants and of their properties can enable the designer to treat lubricants as he does other materials, incorporating them into successful designs.

The advent of new synthetic materials during World War II, particularly silicone and diester oils and greases, provided the solution for many low-temperature lubrication problems. Further development in the direction of materials capable of functioning over a very wide range of temperatures is now needed. The requirement for new test procedures capable of properly evaluating and comparing these new materials, particularly the greases, is becoming daily more urgent, for the efficient utilization of lubricants in new designs is dependent upon our knowledge of their performance characteristics under a wide variety of conditions.

Both oils and greases have a role to play in subzero lubrication. Both are subject to the fundamental requirement of fluidity or mobility at the minimum operating temperature.

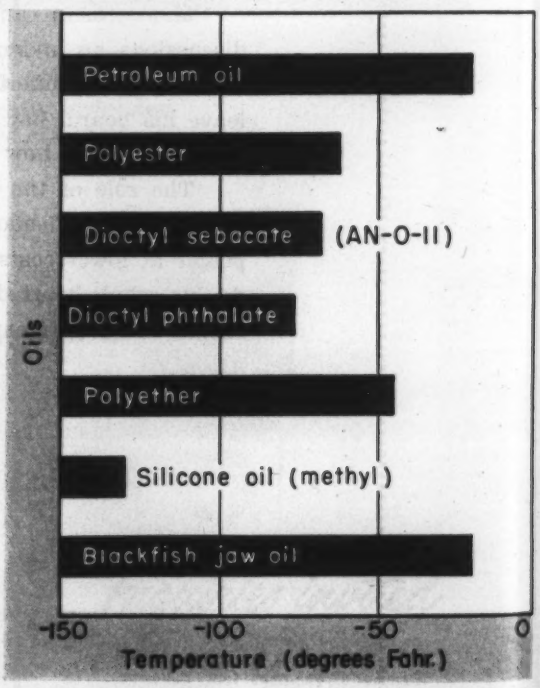
Where Oils Are Used

The role of oils is in the lubrication of sleeve bearings in apparatus ranging from instruments to engines, in the lubrication of pivot bearings in instruments, and in some cases the lubrication of small ball and roller bearings. In addition to lubrication, many applications require effective prevention of corrosion, low volatility at elevated temperatures, and stability over long periods of time. The higher cost of synthetic oils has directed their use in instruments which must function at low temperatures and in which the available torques are relatively low. Modified petroleum products have been made available for large volume applications where greater torque is available for starting and where the lubricant is soon warmed up upon running. Certain of the lower cost synthetics are now finding application in hydraulic and engine installations where fire resistance is desirable.

The role of greases in subzero lubrication is principally in application to ball and roller bearings in instruments, computers, gyros, motors, actuators, controls, and so forth. In some of these applications the grease must also lubricate spur, worm, or helical gears where the lubricity requirements are more severe than in the antifriction bearings. Subzero re-

Fig. 1—Top, left—At air inlet for J-47 aircraft gas turbine during winterization tests atop Mount Washington, N. H.

Fig. 2—Below—Pour points of typical low-temperature natural and synthetic oils. Oil does not pour within range covered by bar



# of Bearings

By Donald F. Wilcock
Thomson Laboratory
General Electric Company
Lynn, Mass.

quirements are met in outdoor installations and in many commercial freezer installations. The most severe conditions are encountered in military and aircraft equipment where temperatures of −67 F and lower must be mastered, *Fig.* 1. In addition to adequate lubrication and freedom of motion at low temperatures, many greases are expected to provide protection against corrosion, to have a low evaporation rate, and to be capable of operating at reasonably high temperatures.

SUBZERO LUBRICATION WITH OILS: The types of oil from which the designer may choose for low-temperature applications include petroleum oil, animal and vegetable oils, and synthetic oils. The petroleum oils are by far the most common and readily available and include products refined from diverse types of crude. As a result, a wide range of properties may be obtained. Animal and vegetable oils cover a very much wider range in both properties and compositions than do the petroleum oils. Blackfish jaw oil, also known as porpoise jaw oil, is widely used as an instrument oil but has too high a pour point for low-temperature work. The synthetic oils are usually the most costly and are used only where their superior properties render their cost unimportant. Some of the synthetics now being used include esters such as dioctyl sebacate and dioctyl phthalate, silicone oils of several compositions, synthetically produced hydrocarbon oils, polyesters and polyethers. These several classes of oils will be discussed specifically with respect to their suitabiliy for low-temperature applications.

Properties that Count at Subzero

Oil properties of greatest importance for low-temperature applications are the pour points, the viscosity-temperature curves, the volatility, and the corrosion resistance. Since petroleum oils even after refining are mixtures of a multitude of compounds, their pour points may be varied over wide limits by proper control of the refining procedure; however, the best that can be expected with normal viscosity materials is about −40 F. *Fig.* 2 shows diagrammatically the pour points which may be expected for several types of natural and synthetic oils.

The viscosity-temperature curves of a number of typical oils are shown in *Fig.* 3. These curves are important to the designer since he normally desires not too high a viscosity at his minimum operating temperature and a viscosity high enough to provide good lubrication at normal operating temperatures.

Volatility is a criterion of the staying power of a

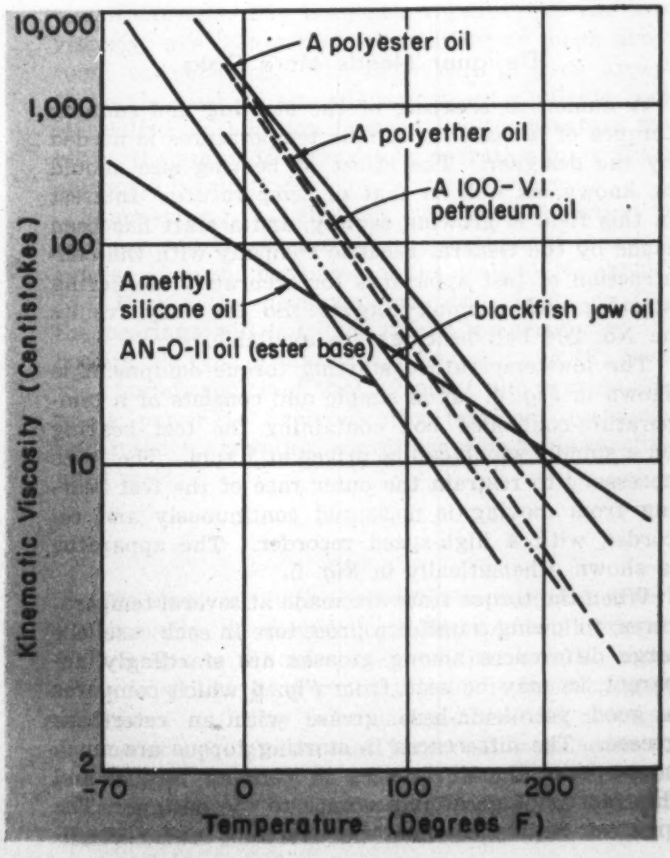
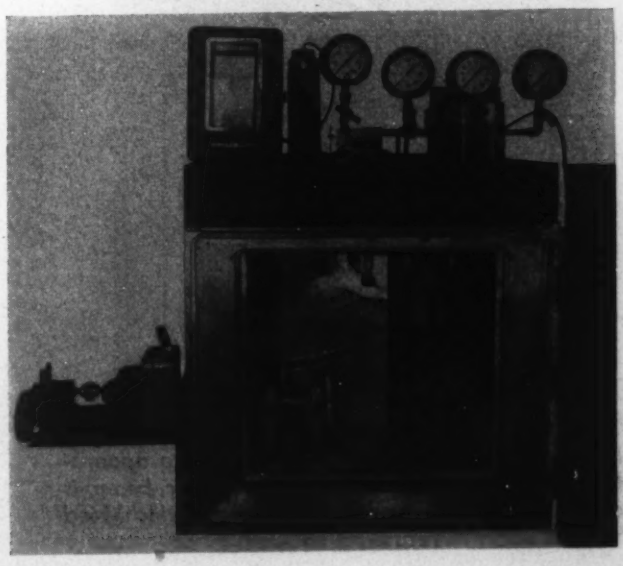


Fig. 3—Left—Viscosity-temperature curves of a number of typical oils

Fig. 4—Below—Equipment used to test bearings for low-temperature starting torque



low-temperature oil when encountering elevated temperatures during operation. The volatility of petroleum oils increases as the viscosity grade decreases, so that low-temperature fluidity is obtained at the expense of increased volatility. Among the synthetics the silicones and the diesters combine low volatility with high subzero fluidity. Silicone oils may be obtained which are essentially nonvolatile at temperatures up to 300 F.

Ability to protect ferrous metals against rusting, combined with an absence of corrosivity toward nonferrous metals such as copper, zinc, cadmium, lead and aluminum, is a requirement of virtually every oil for bearing lubrication. Rust inhibition is obtained from natural or added inhibitors and is a property which must be evaluated on each manufacturer's product. Corrosivity is usually due to acidic impurities or to oxidation products and therefore is also a manufacturing variable being dependent upon the manufacturing process and the type of oxidation inhibition.

SUBZERO LUBRICATION WITH GREASES: Low-temperature lubrication with grease is inherently more difficult than with oil. A low-temperature grease, like other greases, contains 75 per cent or more of oil, the balance being a soap which gives the grease its structure. Consequently, a low-temperature grease can have no better subzero properties than the oil from which it is made. In fact, the soap thickener will always increase the viscosity or resistance to motion of the oil to which it is added. The advantages of using grease—its gradual feed of oil to ball bearings, its cleanliness, and the elimination of oil feed devices and frequent relubrication—outweigh considerably the disadvantage of greater resistance to motion.

Four classes of grease are available today for subzero lubrication, based upon the oil type used in the grease: (1) Petroleum base, (2) ester base, (3) polyglycol base, and (4) silicone base. Lithium soaps are almost universally used in all low-temperature greases because they do not stiffen in the cold as rapidly as other soaps and they have good adhesion to metal surfaces.

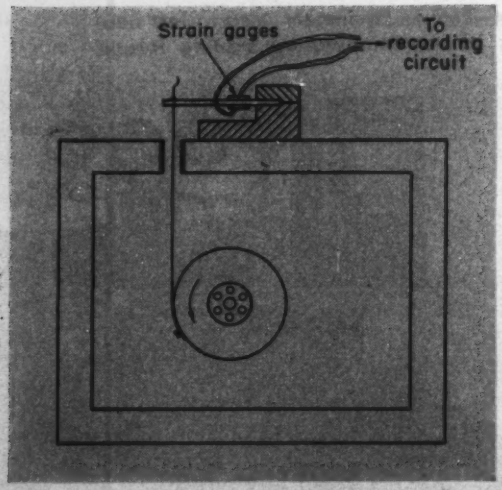


Fig. 5—Diagram of low-temperature torque apparatus, showing how deflection of cantilever beam is detected by strain gages, signals from which feed to recording equipment

Frequently machines which must function at subzero temperatures are designed with too little attention accorded bearing performance and lubrication under these conditions. Thereafter the lubricant is called upon to do an unnecessarily exceptional job. Consideration of factors such as the following during design will permit more efficient design and operation.

1. Allow for the effects of differential contraction when more than one construction metal is used. Stiff operation and binding at low temperatures may not be the result of improper lubrication but of warpage of housings and frames resulting from differential contraction
2. If sleeve bearings are used, sufficient bearing clearance must be allowed so that some clearance will remain at the lowest temperature. Most bearing and bushing materials have contraction coefficients larger than that of steel
3. Where ball or roller bearings are used, if the housing is not steel or does not have a strong steel insert, sufficient clearance must be allowed so that compression of the relatively light bearing outer race, with resultant loss of internal bearing clearance, does not occur
4. Specify the proper lubricant. Many of us have struggled to start cars in cold weather when they were not lubricated with the proper oils and greases. The large differences among oils are shown in *Fig.* 3. Such charts permit rather exact calculation of oil performance at any temperature. The designer needs similar information for greases so that he can provide adequate starting and running power for his machine. Where a number of bearings are involved, a modest decrease in low-temperature bearing torque can mean a sizable reduction in over-all power requirements

Designer Needs More Data

A numerical charting of the starting and running torques of greases at various temperatures is needed by the designer. The effect of bearing size should be known, as well as that of temperature. Interest in this field is growing rapidly, and a start has been made by the General Electric company with the construction of test apparatus for accurately measuring starting and running torque. So far only results on No. 204 ball bearings are available.

The low-temperature starting torque equipment is shown in *Fig.* 4. It is simple and consists of a temperature-controlled box containing the test bearing on a spindle which can be driven at 1 rpm. The force necessary to restrain the outer race of the test bearing from moving is measured continuously and recorded with a high-speed recorder. The apparatus is shown schematically in *Fig.* 5.

When the torque tests are made at several temperatures, following a uniform procedure in each case, the large differences among greases are startlingly apparent, as may be seen from *Fig.* 6 which compares a good petroleum-base grease with an ester-base grease. The differences in starting torque are much larger than the differences in running torque, and this fact is of great importance to the designer. The greatest resistance must be overcome under condi-

tions when the driving torque available is normally the least. However, once this initial resistance has been overcome, the running resistance will be smaller and will be further lessened as friction warms the lubricant. The designer seeking factual information should be skeptical of results from some specification tests which call for intermittent rotation during the cooling period and hence are not truly representative of the worst conditions his apparatus is likely to encounter.

Greases Differ Widely

There may be considerable differences among greases within a given classification. *Fig.* 7 shows the torque-versus-temperature curves for some of the greases meeting Army-Navy specification AN-G-25 for low-temperature grease. A machine must be designed to operate on the worst grease in a class unless a particular product is specified.

Two other factors in addition to temperature, which affect low-temperature torque and are important to the designer, are the time the bearing is held motionless at low temperature, and the radial clearance of the ball bearing. *Fig.* 8 shows the increase in torque as the time at −67 F is increased. After 72 hours the torque may be one-third greater than after one hour. Decreasing the radial bearing clearance likewise causes a rapid increase in torque, as shown in *Fig.* 9 for another grease.

There are a number of properties of greases, other than low-temperature performance, which should be given consideration; namely, good performance at high temperatures, prevention of corrosion, dirt content, and gear lubrication. As an example, by using very low-viscosity oils, petroleum-base greases with extremely good low-temperature properties can be manufactured. But the high volatility of the low-viscosity oils makes them unsatisfactory much above room temperature. The ester-base greases appear to be the best all-around performers available commercially. In addition to good low-temperature mobility, they provide satisfactory operation up to 220 F and good lubrication of gears and bearings.

Summarizing, satisfactory subzero lubrication of bearings can be obtained by the designer if it is considered from the beginning of the design. He should: (1) Design the housings and other parts so that the bearings will not bind at low temperatures; (2) specify the type of lubricant to be used; and (3) know the characteristics of that lubricant and provide adequate power to overcome the lubricant resistance under the temperature conditions which his machine must meet.

"Too many men in management assume that American industry, on the whole, is marvelously equipped. This is due to the misconception that because a machine is still in good running order it is still a good machine . . . Delay in replacing these old machines by modern equipment that turns out more work for the consumer's dollar is a costly perpetuation of inefficiency"—TELL BERNA, *general manager, National Machine Tool Builders' Association.*

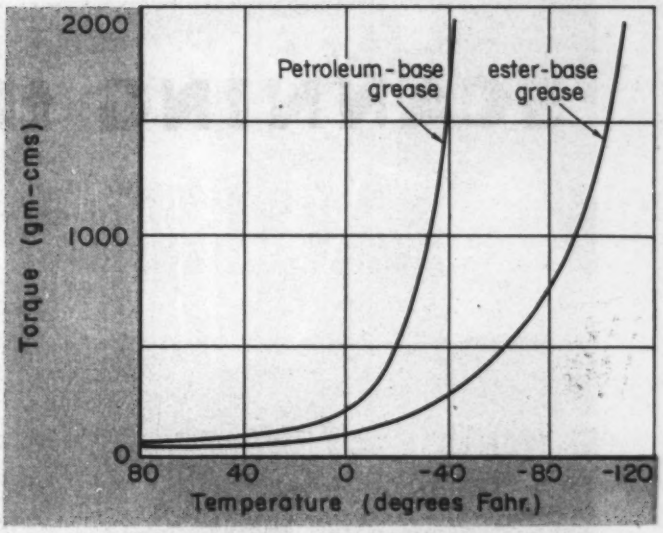


Fig. 6—Starting-torque characteristics of two typical greases over wide temperature range

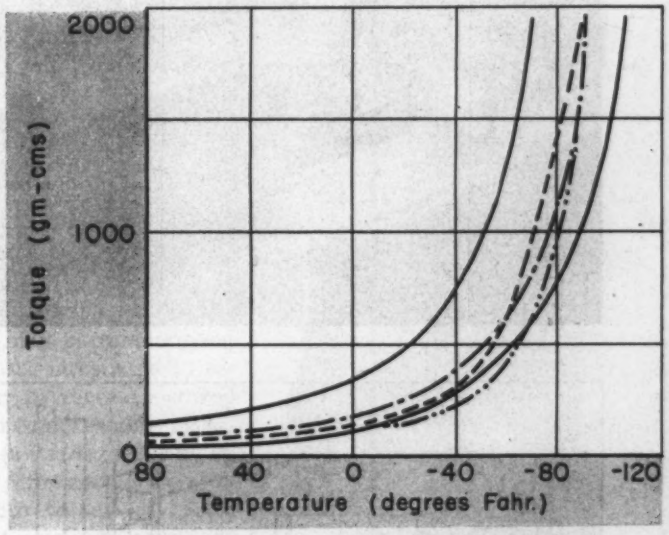


Fig. 7—Starting-torque curves of five greases meeting Army-Navy specification AN-G-25

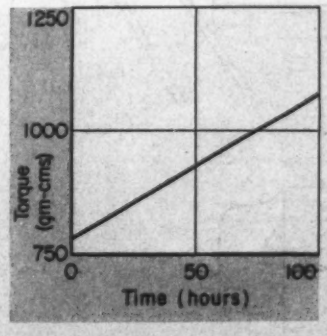


Fig. 8—Effect of time at −67 F before starting upon starting torque

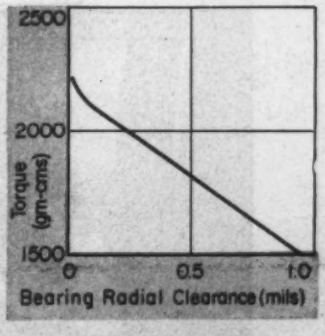
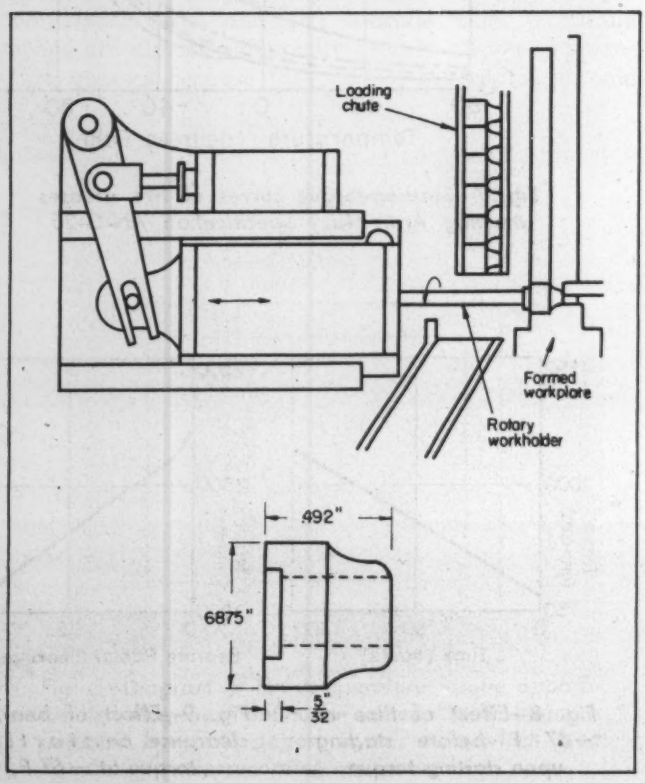


Fig. 9—Effect of bearing clearance on starting torque at −67 F

SCANNING the Field For Ideas



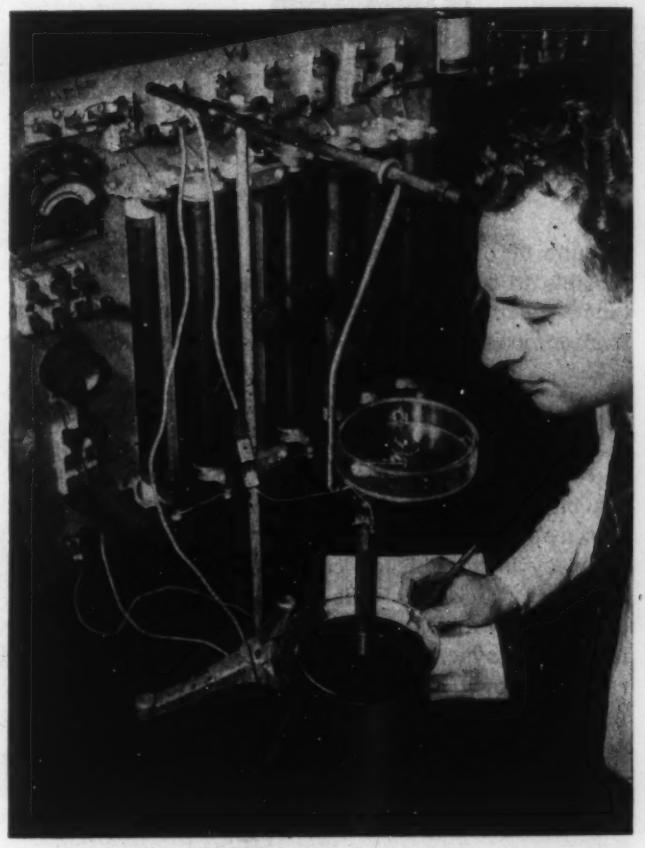
Centerless grinding of small ball bearing cones for bicycle wheels is automatically performed on the machine shown at left, solving the problems of orienting, feeding and holding a difficult-to-handle part. Designed by Arthur Scrivener Ltd., Birmingham, England, the machine plunge-grinds the 0.6875-inch diameter and ball race of this workpiece which is 0.492-inch long. The hopper for feeding the work into the chute has a rotating disk operating at an angle of 45 degrees and carrying a number of selector holes chamfered at the edges to receive oriented workpieces. Attached to the disk are paddles that churn and agitate the pieces until they drop into holes. When the chute is full, a bypass feeds the parts back into the bottom of the hopper.

To prevent the workpiece from being squeezed forward off the workplate during the plunge grind, the shoulder on a rotary workholder backs up the piece as shown in the sketch at left. This workholder is part of the push-feed mechanism which is synchronized with the cycle of the grinder. Before the wheels close, the hydraulic cylinder actuates the workholder which advances and pushes the piece, presented by the chute, onto the formed workplate. Upon completion of the grinding cycle the feed mechanism retracts and the finished piece drops on a discharge chute.

Internal stress in electrodeposited coatings may be measured by a direct-reading instrument, developed by Abner Brenner and Seymour Senderoff of the National Bureau of Standards. Compression or tension in a specimen coating deposited on a standard helix is read from a dial as the helix changes curvature in response to forces acting within the plated layer. The device, called a spiral contractometer, is self contained and requires no auxiliary apparatus. Excessive stress, usually the result of the chemical nature of the plating solution or of impurities in the deposit, may cause peeling, blistering, or cracking of the

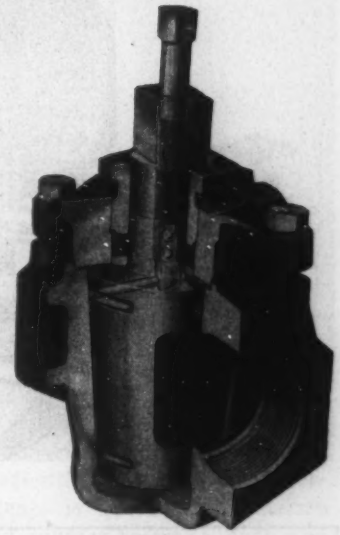
coating and thus render the base metal more susceptible to corrosion. It may also cause failures due to stress corrosion and tend to decrease the fatigue resistance of the plated material.

Helix in the instrument at right is wound from flat metal strip. The upper end is fastened while the lower end is connected mechanically to the pointer of a dial on which the rotation of the helix is indicated. In the axis of the helix, a rod is fastened at its lower end to the helix, and at its upper end to a gear train which produces a 10-fold magnification in the rotation of the dial pointer. Inner surface of the helix is lacquer coated to prevent plating on the inside of the coil. After a test, the deposit may be stripped and the helix reused almost indefinitely. Values obtained with the device are in good agreement with reported data and with measurements made by procedures based on other principles. Stress determinations made on nickel deposits are reproducible to within plus or minus 10 per cent.



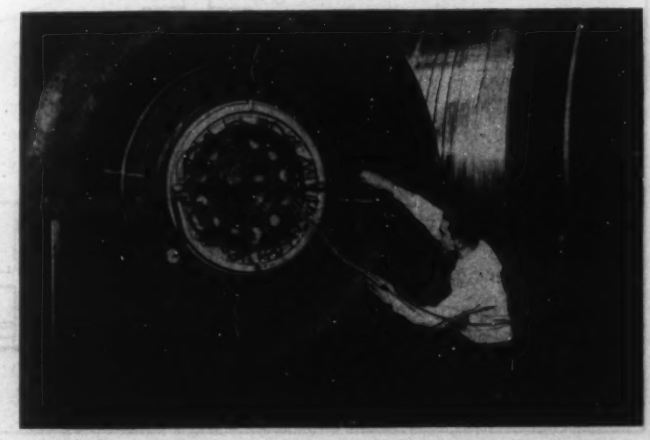
Automatic lubrication for extended periods without the aid of mechanical pressure devices is now a reality through the development of a compressible lubricant. Originally developed by the Nordstrom Valve Division of Rockwell Manufacturing Co. for use in plug valves, right, the lubricant is compressible under pressure to about half its normal volume. Tests now being made on valves have been in progress for months and have proved the success of energizable lubricants known as Hypermatic under most conditions through temperature ranges of 250 degrees (Fahr).

Because this lubricant actually may be compressed, an energized condition is created which the manufacturers claim will automatically feed lubricant to seal seating surfaces and fill voids in event of a leak. The material retains its energy for an almost limitless number of valve turnings and may be re-energized when the pressure finally subsides by adding more of the same substance to refill the valve chambers or by turning the lubricating screw to recreate stored energy. Basically, the lubricant is similar to standard, noncompressible materials in its lubricating properties and wetting action. It is made in stick or bulk form, just as a standard valve lubricant, the main difference being its intrapowered action under working conditions. It flows into voids and maintains an unbroken film surface. When it comes to rest, it again assumes its plastic form with all lubricated surfaces sealed.



Simulated landing strip, right, will give data on what happens to tires during landing of high-speed aircraft. Actually a seven-foot steel flywheel three feet wide, the landing strip is powered by a 150-horsepower Westinghouse motor and controls. The flywheel turns at any speed up to 250 miles per hour. When the tire is moved against it, the effect of an actual landing is obtained. Stored energy in the flywheel can exert the same force as a plane coming in for landing.

When a plane tire is pushed against the flywheel, it gets the same initial shock as when it actually touches a runway. Slowing down the flywheel gives the same effect as a pilot applying the brakes. By varying the



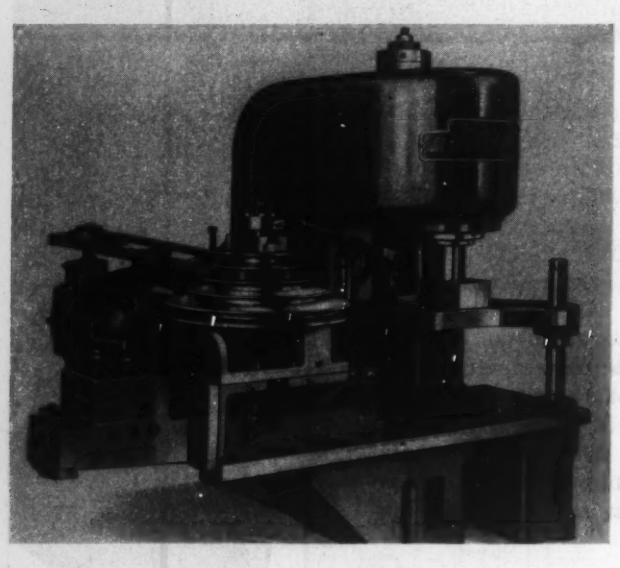
Ideas

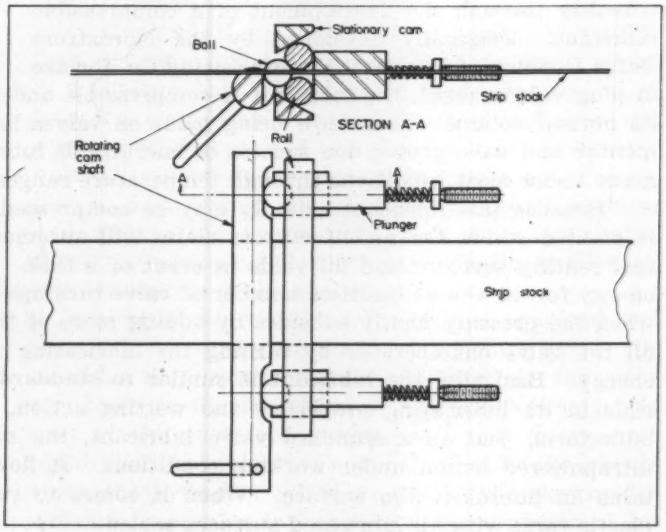
amount of current fed into the driving motor, it is possible to compensate for such things as wind resistance which slows down a plane landing and rolling friction occurring after the plane touches the ground.

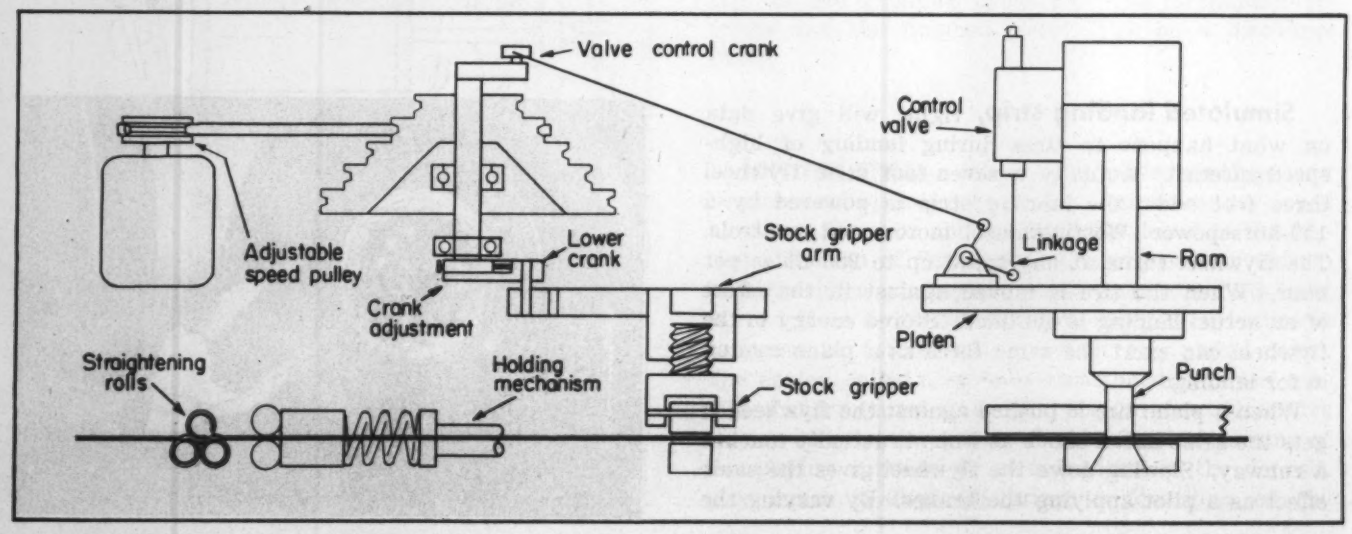
Feeding accuracy of plus or minus 0.002-inch can be maintained with the harmonic stock-feed unit shown below attached to a hydraulic press. This accuracy is possible on coil stock 3 inches wide and 3/64-inch thick for feeds up to 3 inches per stroke. Designed by the Denison Engineering Co., the feeding unit is synchronized with the motion of the press ram as shown in the schematic diagram at bottom. A ¾-horsepower motor rotates a valve-control crank at a speed selected from a multispeed pulley assembly. This raises or lowers a linkage, actuating the hydraulic control valve for the press ram. Being fastened to the ram platen, the linkage affects movement of the valve spool for rapid control of oil flow.

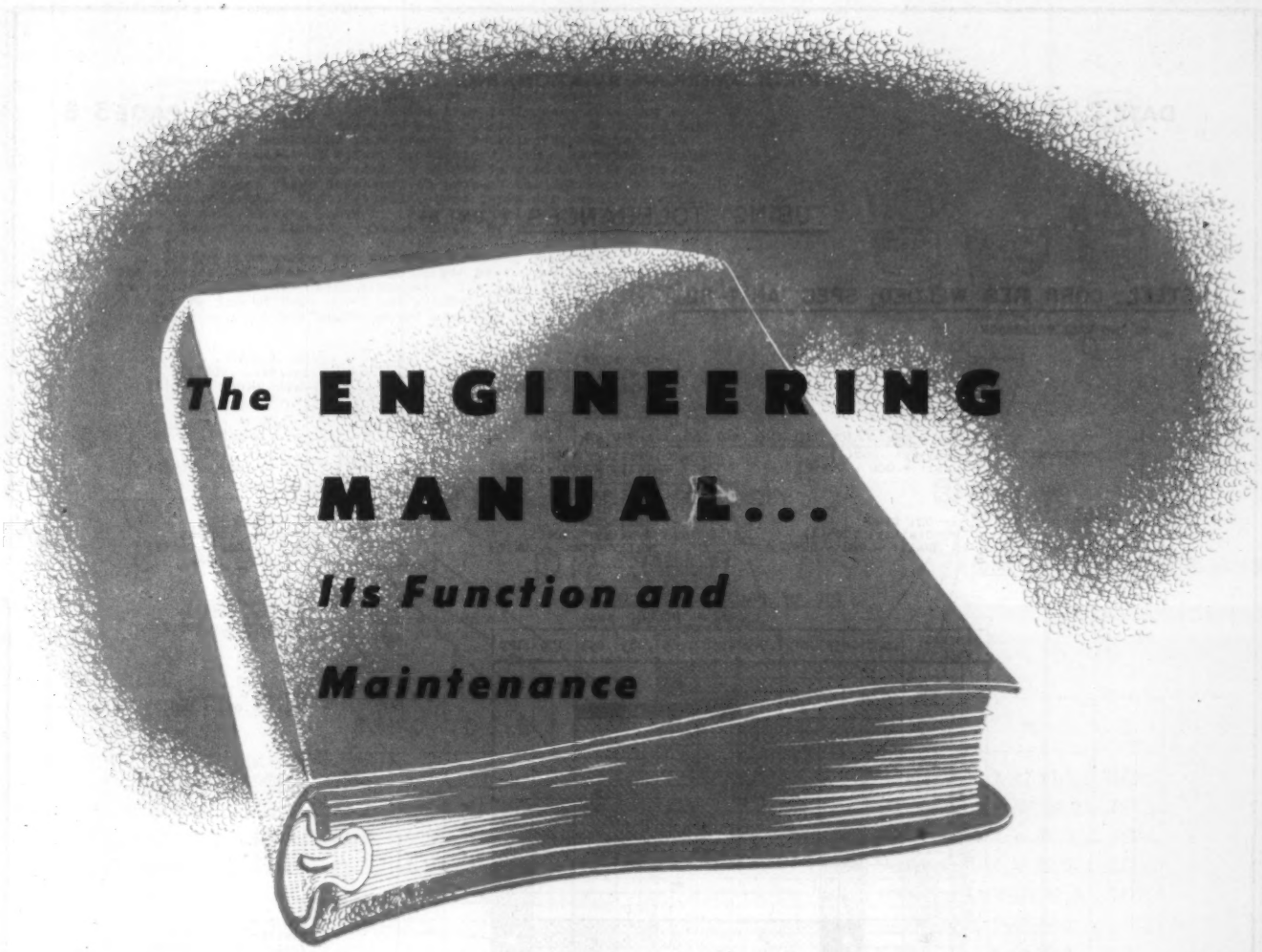
Rotation of the valve crank also rotates a lower crank assembly, oscillating the stock gripper arm. As the gripper arm oscillates in one direction, the gripper jaws are loosened by the action of the threaded gripper assembly. When moved in the opposite direction, the jaws tighten and with the forward motion of the entire assembly the material is advanced a predetermined distance with each cycle.

Action of the holding mechanism to prevent any backward movement of material is shown in the drawing below. In each work cycle, a spring on each side of the mechanism forces rolls against stationary cams which in turn hold the rolls against the strip stock so it is gripped firmly and advanced a preset distance. To release the stock, a rotating cam shaft pushes two balls against the rolls, forcing them away from the stationary cams and out of contact with the stock during the return stroke of the stock gripper. With this arrangement, production rates of 50,000 punched parts per hour are possible with the punch press and feeder shown.









The ENGINEERING MANUAL... Its Function and Maintenance

By J. T. Bennett
Production Design Engineer
North American Aviation Inc.

WHEN properly planned, compiled and maintained, the "Draftsman's Bible", as the engineering manual is sometimes called, can have a profound salutary effect on the efficiency of any engineering organization.

The purpose of a proprietary engineering manual is to supplement the standard engineering handbooks by furnishing, in readily usable form, such information as may be especially suited to the efficient execution of a company's particular engineering projects. Although standard handbooks are indispensable references, they cannot proficiently cover the many special techniques peculiar to individual organizations.

To illustrate how this special kind of information can best be presented, the various subject divisions of North American's DRM (Drafting Room Manual) will be described.

An alphabetical index containing several hundred entries occupies the first two sheets. This index is changed each time it is affected by changes in the remainder of the manual in the belief that an obsolete index is worse than no index at all. Entries are based on only such key words as might reasonably occur to an engineer impatiently searching for information. A table of contents is not needed because the manual is divided into subject sections, each one marked by index-tabbed dividers.

An annotated listing of more than two hundred commonly used materials comprises an entire section. The notes are intended to furnish complete guidance for the use of each material, from selection of the most economical material to the exact method of specifying it on a drawing. This section is not only frequently used but also must be frequently revised if maximum benefit is to be obtained from the constant developments occurring through materials engineering.

Closely allied in usage is an adjacent section giving the sizes and tolerances of these materials. Where practicable, this listing also serves to limit the variety of sizes used. While preparation of this section does not require much literary ability, it offers an

DRAFTING ROOM MANUAL
NORTH AMERICAN AVIATION, INC.

DATE 2-14-49 SECT. III PAGE 3-6

TUBING TOLERANCES (CONT'D)

STEEL, CORR RES WELDED, SPEC AN-T-82

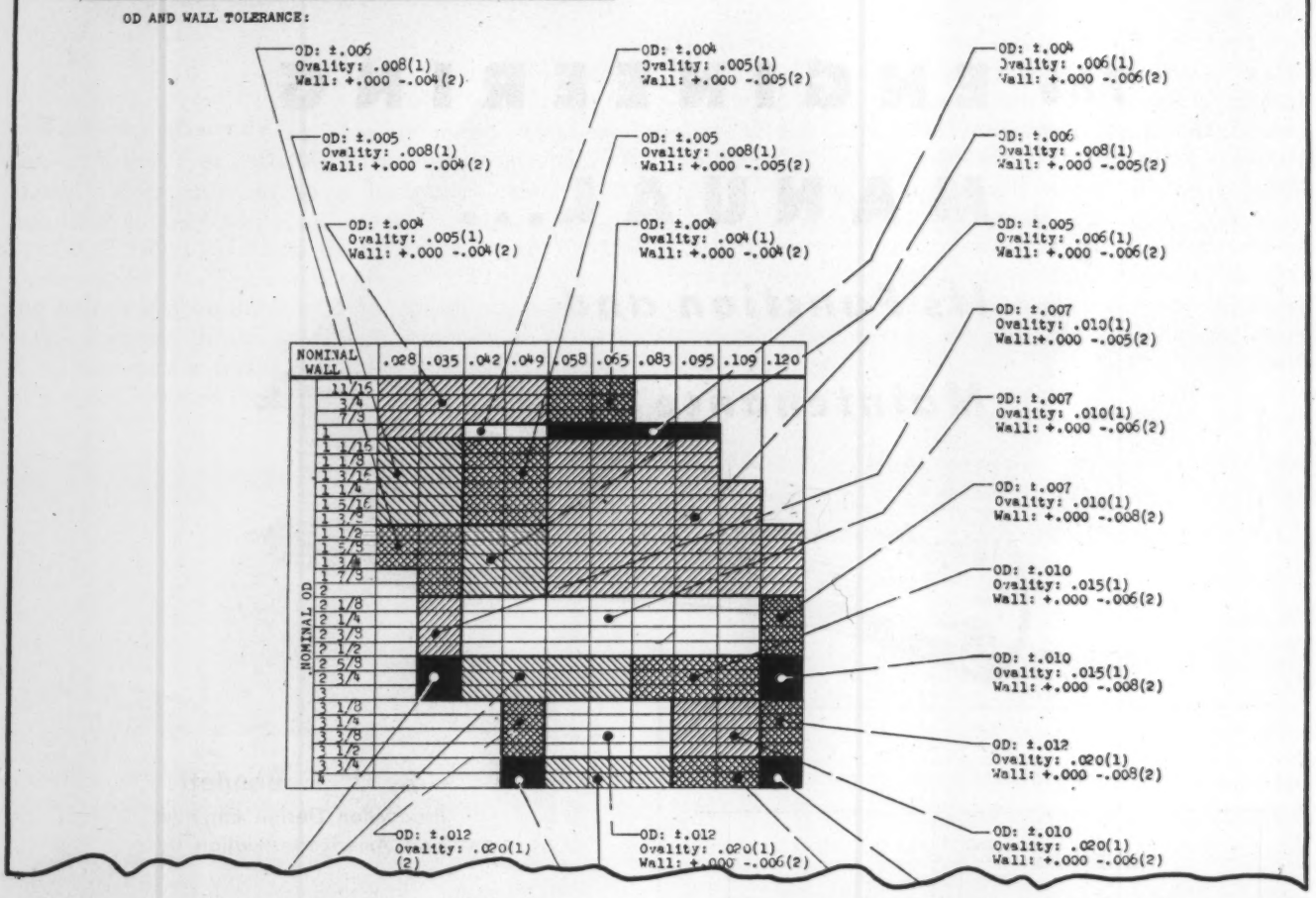


Fig. 1—Important section of engineering manual is that which lists available forms, sizes and tolerances of materials. Here a unique chart gives all pertinent size data on corrosion-resistant welded steel tubing

opportunity for more effective presentation than is generally encountered in commercial catalogs and specifications, *Fig.* 1.

A rapidly expanding section that finds increasing use pertains to standard parts. In some respects this is the most interesting section because of the variety of its contents. It is informally divided into three groups: Machine parts, plumbing, and hardware, the last one consisting mainly of fasteners. This seems like a meager collection of subjects and one may wonder why, for example, there is no mention of electrical parts. At North American, certain subjects such as electrical engineering are assigned to specialty groups. The DRM can not efficiently cater to individual groups. Specialties that are thus omitted are effectively handled by the engineering groups concerned. The Hydraulics Group, for example, maintains a supplementary manual.

In the standard-parts section, the treatment of subjects not only supplies design recommendations for use of the parts listed, but generally follows through to the method of specifying the required information on drawings. In some instances, guidance is given for the design of special parts similar to, or mating with, standard parts. This section of the DRM, in addition to being a comprehensive index of such standard parts as are contained at random in the separately bound Standards Book, serves as a commercial-parts catalog. Here, too, much can be done toward effective presentation of material obtained from commercial sources, *Fig.* 2.

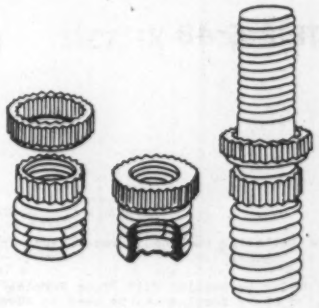
Information on the design of threaded parts occupies a separate section. Preferred threads are listed consecutively by diameter. All pitches and fits are shown in a continuous list, but staggered to indicate preference.

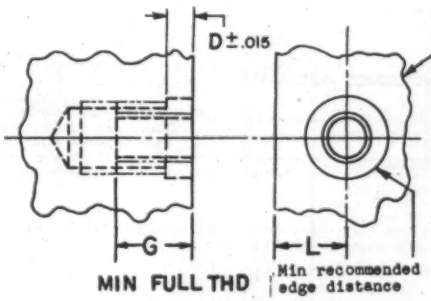
A section on machining includes instructions in the use of the microfinish standard and several pages

Wichita City Library

Threaded fasteners incorporating the Rosan locking feature are available in several designs, some of which are herein illustrated. The universally applicable type includes a matching internally and externally serrated collar which is to be forced into a counterbored recess and thus prevent rotation of the threaded insert. The equivalent effect is obtained with a serrated shoulder on inserts that are to be cast or molded in place. This type is furnished capped where necessary to prevent the entrance of surrounding material. The straight-tapped types are available with plain or self-locking threads. Other variations include plain holes, taper pipe threads, gasket seals, solid plugs, and dovels.

Design information for the most commonly used type follows. The slotted bottom end makes the thread self-locking. Material is low-carbon steel, cadmium-plated. The ring is case-hardened and may be forced into steel not exceeding the 125,000 - 140,000 psi range or into any heat-treated aluminum alloy.





(1) DRILL A, DEPTH B
CBORE C $^{+.003}_{-.000}$ DIA, .010-.020 FILLET R
TO DEPTH SHOWN
CSINK 120° X E
TAP K TO DEPTH SHOWN
PD F
PER SPEC AN-S-126

(2) H INSERT 1 REQ
J RING 1 REQ
INSTALL PARTS FLUSH TO .010 MAX BELOW SURFACE

Add general note:

(2) ROSAN, INC. SOUTHGATE, CALIF.

(1) CONCENTRIC WITHIN .006 TOTAL INDICATOR READING

INSERT INTERNAL THREAD	A	B	C	D	E	F	G	H	J	K	L
8-32 NC-3	#7(.201)	9/16	.328	.109	1/4	.2175 $^{+.0026}_{-.0000}$	5/16	RD1408H-5L	RL213B-6	1/4-20 NC-3	11/32
10-32 NF-3	F(.257)	19/32	.359	.125	5/16	.2765 $^{+.0030}_{-.0000}$	11/32	RD2053H-5.5L	RL243B-7	5/16-18 NC-3	1/4
1/4-28 NF-3	5/16	21/32	.421	.141	3/8	.3344 $^{+.0032}_{-.0000}$	13/32	RD2063H-6.5L	RL283B-8	3/8-16 NC-3	5/16
5/16-24 NF-3	27/64	23/32	.515	.156	1/2	.4500 $^{+.0037}_{-.0000}$	15/32	RAD2073H-7.5L	RL333B-9	1/2-13 NC-3	3/8
3/8-24 NF-3	31/64	13/16	.593	.156	9/16	.5084 $^{+.0040}_{-.0000}$	9/16	RD208SH-9L	RL383B-9	9/16-12 NC-3	7/16
7/16-20 NF-3	17/32	13/16	.734	.172	5/8	.5660 $^{+.0042}_{-.0000}$	9/16	RD209SH-9L	RLA73B-10	5/8-11 NC-3	1/2
1/2-20 NF-3	41/64	15/16	.875	.172	3/4	.6850 $^{+.0045}_{-.0000}$	11/16	RD210SH-11L	RL563B-11	3/4-10 NC-3	5/8

Fig. 2—Standard parts section of engineering manual provides all data required to apply and specify parts competently in design. Good example of technique employed is this page on Rosan fasteners

on specific machining operations, *Fig.* 3, among them flame cutting, which takes the place of rough machining, although in equipment it is more closely allied to welding. Information on gears and related subjects now included will shortly be transferred into a new section.

A section on fabrication includes blanking, piercing, and forming of sheet metal and plastics as well as forming of tubing, extrusions, bar and wire. Many details of sheet-metal design are standardized at North American and may be specified by drawing or specification number. An extensive treatise on riveting completes this section, although it does include standard rivets and perhaps could logically be grouped with standard fasteners.

The design of cast, forged, and extruded metal parts is grouped in a section that also includes the design of molded nonmetallic parts. Most of these pages are characterized by numerous small illustrations of design details, *Fig.* 4.

Information relating to structural design, including material design values and joint strengths, comprises another section. This is printed in larger quantity than the remainder of the manual, the additional copies forming a part of a separate manual for the Structures Group.

The application of finishes, markings, cementing, and electrical bonding seems to find satisfactory companionship in a section of somewhat heterogeneous information, *Fig.* 5. This is followed by a brief section on heat treatment, another on welding, brazing, and soldering, and the inevitable miscellaneous section devoted to such items as tables of weights and measures. The final section, covering drafting procedure, explains in considerable detail how to prepare drawings for North American Aviation Inc.

Since the sole purpose of engineering is the solution of problems, the purpose of the manual as an engineering aid is to supply the required facts in the form most convenient for use. Thus, the first requisite in the preparation of copy is familiarity with the questions that require answering. The second is the necessary knowledge to answer the questions. The third and final requisite is the ability

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DATE 12-6-48 SECT. VII PAGE 5-1

TUBE MACHINING

The following routine is recommended in determining machining limits of tubing.

1. Refer to section VIII "Tube Forming" and determine if swaging or other forming can be used to advantage with or without subsequent machining.

2. Refer to section III "Tubing Sizes" and select the most economical standard size for trial calculation.

3. Refer to section III "Tubing Tolerances" for diameter, wall, and straightness tolerance.

4. Calculate OD max and ID min that may be machined from the size selected and compare with proposed OD max and ID min of the machined part. For parts to be machined from standard-tolerance tubing, calculate as follows.

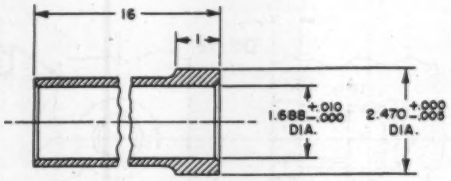
Machined OD max = Tube OD min - Allowance*

Machined ID min = Tube OD max - 2 x Wall min + Allowance*

* Allowance is total required for camber and clean-up, as shown in the following table. Intermediate values may be obtained by interpolation.

Max distance from holding device (chuck, steady rest, or center)	Total allowance for camber and clean-up		
	Straightness tolerance .010 in. per ft	Straightness tolerance .015 in. per ft	Straightness tolerance .020 in. per ft
0	.005	.005	.005
1	.008	.010	.012
2	.012	.015	.018
3	.015	.020	.025
4	.018	.025	.032
5	.022	.030	.038
6	.025	.035	.045
7	.028	.040	.052
8	.032	.045	.058
9	.035	.050	.065
10	.038	.055	.072
20	.072	.105	.138

In the example shown, machining of the ID for the required distance of 16 in. permits a max unsupported distance of 8 in. For the OD, the max unsupported distance (for the critical diameter) is 1 in.



Material is 4135 steel mechanical tubing. Tolerances for 2 1/2 OD x .500 size are as follows.

OD: +.010 -.000
Wall: ±10%
Straightness: .015 in. per ft

Calculating for machined OD max:

Tube OD min	= 2.500	
Allowance	= .010	
Difference	= 2.490	= Machined OD max.

Calculating for machined ID min:

Tube OD max	= 2.510	
2 x Wall min	= .900	
Difference	= 1.610	
Allowance	= .045	
Sum	= 1.655	= Machined ID min

From comparison of these results with the required dimensions it is evident that the selected size is satisfactory. It is also apparent without further calculation that 2 1/2 OD x .500 is the most economical standard size.

Fig. 3—To help the designer in specifying finish machining of parts, a section of manual is devoted to pertinent facts on the design, dimensioning and tolerancing of machined parts. Page here duplicated deals with parts which will be machined from tubing

to present the information in readily usable form.

Maximum efficiency in anticipating what will be required and in meeting the need demands that all persons who prepare copy for the manual be in close touch with engineering projects, preferably by active participation. In a large engineering department where many projects are simultaneously in progress, this can be accomplished by organizing such personnel according to design specialty, each specialist being a design consultant as well as a contributor to the manual.

Effective presentation of material requires actual engineering experience, preferably in the same organization. To assign even the best technical writer who is unfortified by experience to the task of guiding seasoned engineers is not only folly, but an insult to the engineering profession. If the required qualities cannot be found in one individual, then it is advisable to have two people collaborate; one with writing ability and another with local engineering experience.

At first thought, it may seem that design specialists would be reluctant to release for publication such information as may tend to reduce the demand for their services. The fallacy of this assumption has been demonstrated by experience. The opposite trend prevails, as specialists who are sincerely interested in self-improvement to keep ahead of the field are only too glad to be released from tasks that have become routine. These specialists thus have more time to assist with the more difficult and more interesting problems.

Preparation of copy is often instrumental in uncovering gaps or errors in knowledge, for there is no better way of learning about a subject than to try to write about it factually. The hem-and-haw specialist who can get by in conversation by laying a verbal smoke screen discovers that similar evasive tactics will not work in the preparation of copy for the manual.

Anticipate Future Requirements

Regardless of the size of a manual, it is advisable to plan for eventual expansion. For example, the wrong method of numbering pages may later cause frequent reprinting for no other reason than to permit insertion of new material. The rules of format and style should be kept as simple as possible, but

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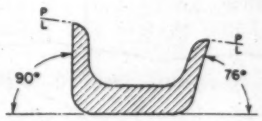
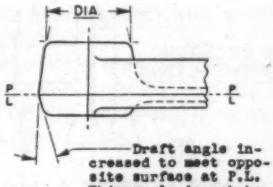
DATE 3-18-46 SECT. IX PAGE 2-2

DIE FORGINGS (CONT'D)

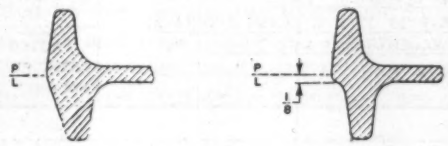
It is also often possible to eliminate machining by taking all necessary draft on a non-critical surface and eliminating draft from an opposite surface.



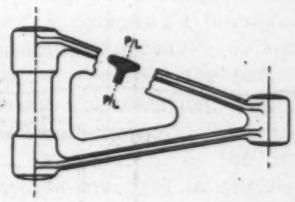
For sections not symmetrical about the P.L., but which are defined by the same dimension parallel to the P.L., the general rule is to increase the draft on the more shallow draw to meet the draft on the deeper draw.



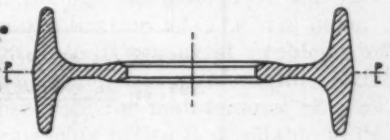
Similar conditions occur when two draft surfaces are offset with respect to each other in a direction parallel to the parting line, as in the case of a flange to be machined at an angle. If the offset is not large, draft should be increased on one surface, to meet the opposite surface as above. Where the offset is large, it may be more economical to use the same draft angle on both sides of the P.L. If this is done, a ledge at least 3/32 high should be provided at the P.L.



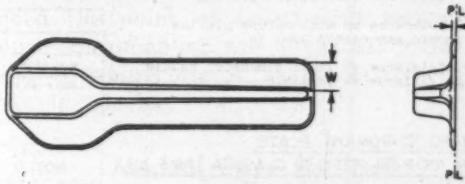
Large webs may be punched out when not required for strength. Such a punchout will minimize the effect of a thin web, since a gutter to receive the excess metal may be added in the punched-out area.



To increase the rigidity of a punched-out web, a bead may be added around the edge of the hole.



Where the web appears as a fin, projecting from a heavier mass in the center, the thickness may be reduced to 3/32 for small forgings.



For this type of forging, thickness "T" may be reduced to 3/32 provided the flange width "W" is not greater than 1".

DEPRESSIONS

A narrow, deep depre[illegible] in the forging represents

Fig. 4—This section of manual gives designer practical tips on design of forgings such as will help to insure efficient, trouble-free production

should be sufficiently definite so that the manual will conform to accepted rules of composition and will be consistent in treatment, permitting nontechnical personnel to take over the edited manuscript at the earliest opportunity and prepare the final copy with little additional guidance.

In regard to the condition of edited manuscript, the most efficient stopping point in editing is greatly influenced by the ability and disposition of assisting personnel. Intelligent selection and management of nontechnical personnel is perhaps the most important factor in efficient operation, as serious deficiencies here are not readily apparent but can easily result in enough additional work for the technical staff to reduce the total output by fifty per cent.

North American maintains more than five hundred copies of the DRM; many of them outside of the Engineering Department, as some of the information is useful to other departments. Distribution in the Engineering Department is one book to about every four engineers.

Maintenance of the DRM is one of the responsibilities of the Design Standards Group, which consists of specialists in various fields of production designing and the necessary assisting personnel. Information is obtained from many sources, but all copy originates in the Engineering Department and is edited in the Design Standards Group.

Proposed changes are indicated in a master copy of the manual. All related reference matter is placed in an active manuscript file arranged in the same manner as the manual. After each release of printed pages, exhausted reference material is retired to a similar inactive manuscript file. One copy of each new printed page is placed in chronological order with previous issues of the same page in a file representing the obsolete manual, from which old pages are not removed.

At present the manual contains about 250 pages. Frequency of revision varies between three weeks and three months, depending on the urgency of the changes involved and the pressure of other work. The quantity of pages in a single release is preferably limited to about ten, for easier assimilation of information, but has been as large as fifty. Also, the difficulty of publishing a large release increases rapidly with size. It not only represents an abnormal load for everyone concerned, but may reach such size that during preparation of final copy for the last few pages of the release a large proportion of the editorial staff's time is absorbed by new changes

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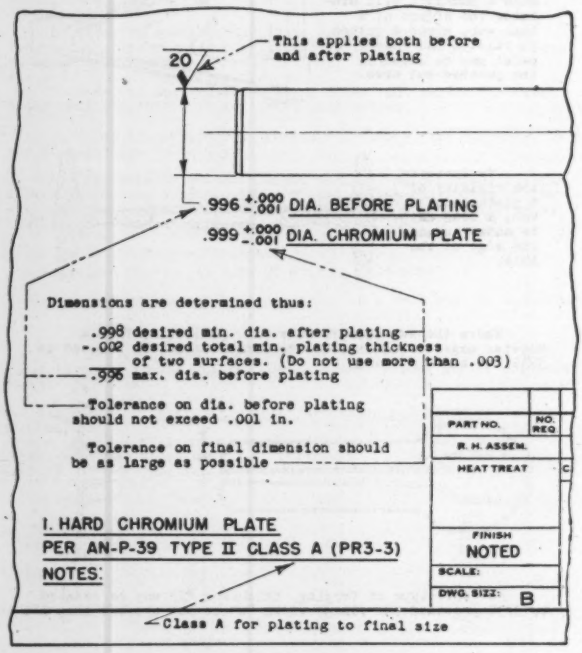
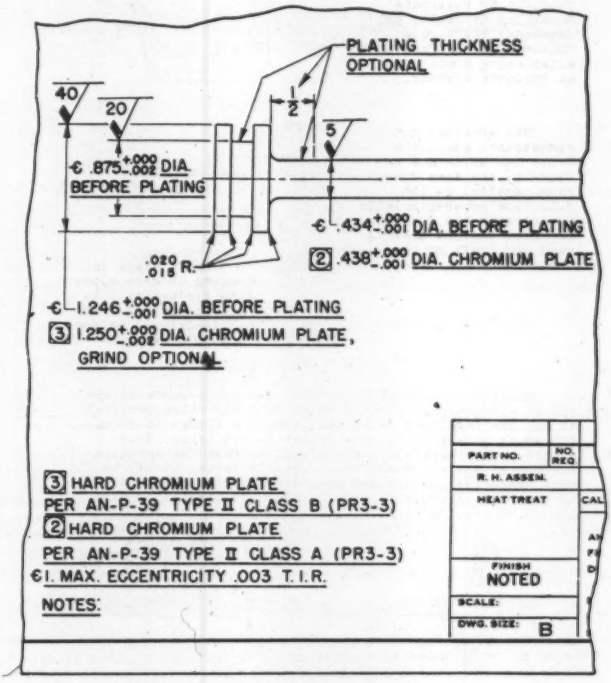
CHROMIUM PLATING (CONT'D)



HARD CHROMIUM PLATING TO FINAL SIZE.
(REQUIRED PLATING THICKNESS MUST NOT EXCEED .002 IN.)



HARD CHROMIUM PLATING ON A STEPPED CYLINDER; SMALLEST DIAMETER PLATED TO SIZE.
(THE MINIMUM PLATING THICKNESS ON THE SMALLEST DIAMETER MUST EQUAL OR EXCEED THAT ON THE LARGER DIAMETERS.)

Fig. 5—"How To Specify" section of manual covers specification on drawings of all types of finishes, of markings, cemented joints, etc. This page covers specification of chromium plating

that must necessarily be made in final copy that is merely awaiting release. In spite of the frequency and extent of changes, however, some pages of the manual are not revised for several years, most changes occurring in subjects that are undergoing unusual development.

The manual is housed in a durable three-ring loose-leaf binder. Pages are 8½ by 11 inches, printed on both sides of lightweight but sufficiently opaque white ledger stock. Printing is by the offset method, for which plates are prepared by photographic process from final copy. Text for final copy is prepared on a standard typewriter equipped with pica type. Drawings and display lettering are prepared with ink. The separate pieces of paper containing material for each page are arranged on a single 17 by 22-inch sheet of paper and mounted with rubber cement. The resultant "paste-up" is photographically reduced to 8½ by 11 inches during the process of preparing a plate for printing. There are a number of real advantages to this method of preparing final copy:

1. The final copy, or paste-up, which is actually an enlargement of the page to be printed, can be prepared by the typist under editorial supervision, given final check in the same department, and released for reproduction without the necessity of making further checks during the printing process.

2. The two-to-one reduction, accomplished without additional cost, is a tremendous advantage in saving of space.

3. The exact two-to-one linear reduction is an advantage in calculating available space during editing and in preparation of sketches. This ratio is rigidly maintained, as is the size of type, for the sake of the user and to expedite future changes. Such illustrations as may be scaled or traced by draftsmen can be prepared exactly double size for the paste-up.

4. The reduction permits finer detail in the preparation of illustrations.

5. The paste-ups, which are filed in the same department after they have been photographed, permit extensive changes. Unwanted material can be peeled off, painted out with white ink, covered with blank paper, or covered with new material which may be added as required. If necessary, the entire 17 x 22-inch paste-up can be cut into pieces for rearrangement on a new sheet. This versatility is a tremendous advantage for

editing and for revisions after publication.

6. Proposed alternations on existing pages of the manual that would be too difficult to indicate directly on a copy of the printed page can be conveniently indicated on a sheet of transparent paper laid over the enlarged paste-up.

7. Although seldom done, printed material from other sources may be directly reproduced. For example, drawings of bearings may be clipped from catalogs and cemented in the desired position. Similarly, photographs may be used to save drafting expense or to provide better description. However, these will require half-tone screening.

8. While new pages are being printed, the paste-ups are available for reference.

9. Very minor changes may even be made by retouching the photographic negative, thus saving time and the expense of preparing a new negative.

10. If desired, the printing plates may be saved for reuse in printing unchanged pages that are on the reverse side of changed pages or for obtaining additional copies in the future.

Layout Should Be Standardized

Page layout may be expedited by the use of guide lines on a transparent surface that can be illuminated from below. Similarly, the use of a standard heading for all pages, whether left or right, eliminates confusion. For the North American DRM, the standard page heading is printed double size in quantity and cemented on the paste-up with suitable numerals to indicate date and page number. Another way is to use a single equivalent mask for all pages of the manual when the photographic exposures are being made.

Distribution of new pages is accomplished through the established mail service within the plant, using envelopes permanently addressed to persons who are assignees of manuals. Each release is accompanied by a change notice enumerating the pages that are to be removed or added and briefly summarizing the changes. This notice, when circulated to users of each manual, enables efficient appraisal of all changes by everyone concerned. In most instances, only the assignee of each manual actually sees the new pages at this time. Obsolete pages are returned in the same envelope, which is provided with a preaddressed flap specifically for this purpose.

Despite inspection of the contents of returned envelopes, it is necessary at intervals of approximately one year to issue tally lists of active pages and dates for the purpose of checking manuals for obsolete or missing pages.

As may have been noted when mention was made of the reduction of pica type to half size, the text is in rather small letters, not really suitable for prolonged reading. This apparent deficiency is believed to be partly balanced by the more advantageous arrangement possible and by the judicious use of titles and subtitles. The small type is possibly no great hardship, as the manual is not intended to be used as a textbook but rather for brief reference. This thought has also been a guiding policy in the preparation of copy throughout the manual. While presentation of subject matter is aimed at ready applicability to design, it is assumed that the user is in possession of a certain necessary background of formal education or equivalent experience. For maximum utility, of course, the manual must begin close to the lowest level of technical knowledge known or suspected to exist in the minds of potential users.

The amount of effort expended on maintenance of a manual is influenced not only by the nature of the engineering project, but to a large extent by the engineering policy of a company's management. There is an absolute minimum "manual", or equivalent established information, required for bare functioning of the engineering organization, and there is also a reasonable maximum beyond which the returns do not justify the expense. Since the diversified and complex operations involved in engineering do not permit a precise calculation of the profit to be derived from publication of a given page, management's insight into the general problems of the engineering organization is a vital factor. Existence of an effective program for maintenance of a manual in any large engineering office is a reliable indication of efficient organization and progressive management. The opinion shared by most working engineers is that few manuals have even remotely approached the point of insufficient returns. Those who use the manual are presumably in the best position to appreciate it as an extremely efficient labor-saving device.

Manual Pays for Itself

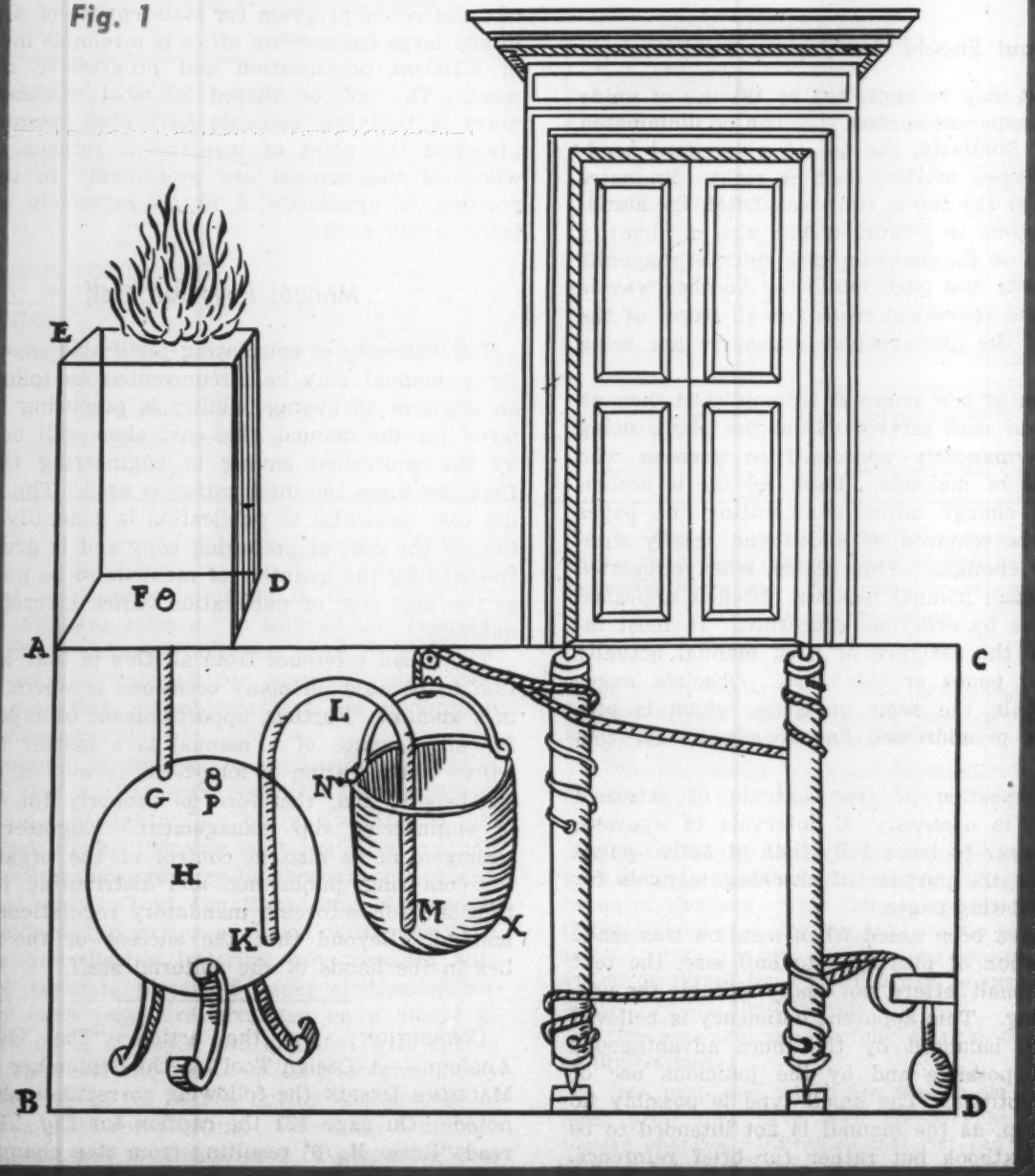
The difficulty of calculating justifiable expenditure for a manual may be circumvented as follows. If an engineer of average ability is preparing the material for the manual, this cost alone will be repaid by the equivalent saving in engineering time the first few times the information is used. The remaining cost incidental to publication is generally a fraction of the cost of preparing copy and is greatly influenced by the quantity of manuals to be published, as the unit cost of publication varies inversely with quantity.

The broad inference from all this is that information to be used on many occasions is worth placing in a manual. Further, apportionment of expenditure for maintenance of a manual is a matter that requires consideration of long-term as well as immediate benefit and, therefore, is properly the concern of engineering top management. Engineering top management is also in control of the organization for collecting, publishing, and distributing information and for enforcing mandatory regulations in the manual. Beyond this, the success of the manual lies in the hands of the editorial staff.

CORRECTION: In the article "The Electronic Analogue—A Design Tool" in the September issue of MACHINE DESIGN the following corrections should be noted: On page 121 the caption for *Fig.* 21 should read "Ratio M_m/θ^* resulting from step change in θ^*. Settings as in *Fig.* 20". On page 123, last line, *Fig.* 16 should be changed to *Fig.* 24. On page 124, line 5, *Fig.* 30 should be *Fig.* 27. Also on page 124, line 6, *Fig.* 21 should be *Fig.* 28, Fig. 25 should be *Fig.* 30.

Highlights in the History of MACHINE

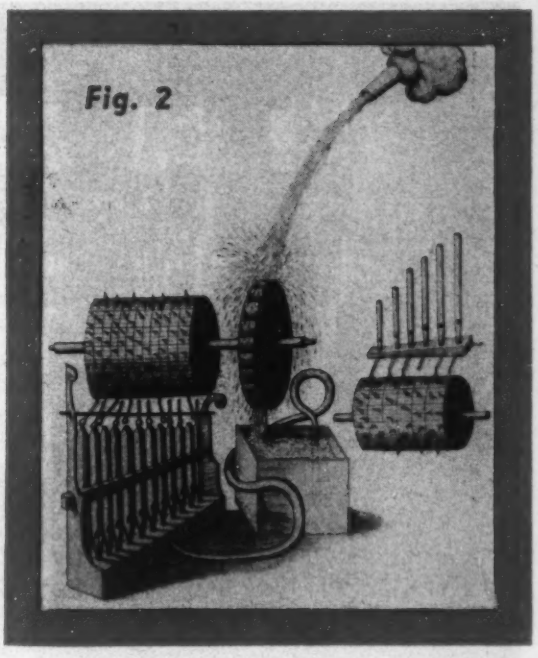
Fig. 1



HYDRAULICS

Part I · Air Hydraulics

By H. G. Conway
Technical Director
British Messier Ltd.
Gloucester, England



ALTHOUGH modern hydraulic machinery development dates from the invention of the hydraulic press by Joseph Bramah in 1795, and received its principal impetus in the middle of the nineteenth century, the early history of hydraulic machines is as old as the history of machinery itself. The need for water distribution for domestic and irrigation purposes stimulated the invention of the first pumps over 2000 years ago, and was responsible for the evolution of pistons and cylinders, valve gear and the air vessel or hydraulic accumulator. The need for hydraulically operated mills and furnace blowers resulted in the invention of rotary pumps and motors some 500 years ago. And the demand for improved fire engines refined the water pump in the seventeenth and eighteenth centuries.

Early engineering literature is rich in descriptions and illustrations of hydraulic and pneumatic machines. The books by Ewbank (1842), Belidor (1739), Leupold (1724), Serviere (1719), Fludd (1618), Ramelli (1588), Agricola (1546), Vitruvius of Rome (25 B.C.) and Hero of Alexandria (circa 150 B.C.) are of exceptional interest and are among the sources of this and subsequent articles in this series.

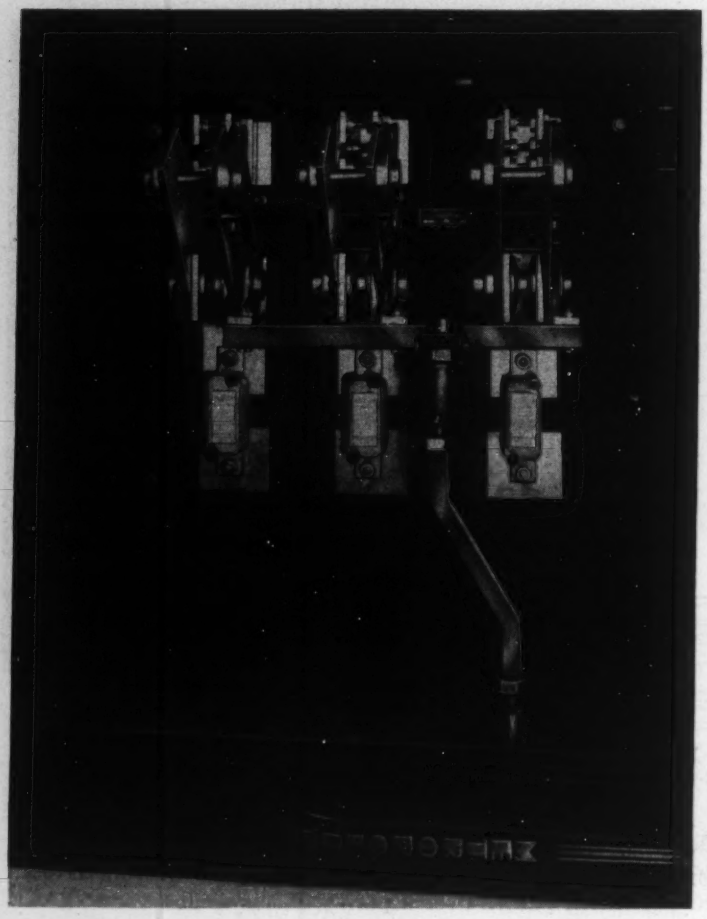
What seems to have been one of the first known hydraulic applications was described by Hero over 2000 years ago and may not have been new then. The machine (*Fig.* 1) was used to open the doors of the temple when the holy fire on the altar was lighted.

In the upper portion of the figure, reproduced from a 1575 edition of *Heronis Spiritalis,* is the interior of a temple with the door on the right and an altar on the left. The altar contains an airtight receptacle in such a position that it will be subject to great heat as soon as a fire is lighted. This receptacle communicates by a pipe with a larger receiver partly filled with water, and placed in a hidden excavation below the temple floor. A syphon pipe leads from this receiver into a bucket suspended from a cord which passes over a pulley and is wound round a vertical shaft firmly secured to the door above, and pivoted at the bottom. Attached to this shaft is another cord wound in the opposite direction, passing over another pulley and supporting a weight. The action of the apparatus is as follows:

When a fire is kindled on the altar, the air receiver under it is heated, the air expands, and acts on the water in the large receiver, forcing it through the syphon pipe into the bucket. As soon as sufficient water has entered the bucket it drops, opens the door and raises the counterweight. The apparatus is so proportioned that the bucket reaches the ground before the syphon pipe is quite uncovered. When the temple services are concluded and the fire extinguished, the air receiver cools down, the air in it contracts and sucks the water back from the bucket. The counterweight then closes the door. Presumably no vulgar eyes were allowed to see by what earthly means the gods signified their approval of the burning sacrifice by mysteriously opening the temple door.

The principle of the displacement of air in a vessel by water entering it was a favorite one of Hero. He constructed various magic fountains and the like in this manner. It was he who devised the first known example of jet propulsion in his whirling "aeolipile" driven by escaping hot air.

Another application is the music machine or organ illustrated in *Fig.* 2 (reproduced from the book by Robert Fludd, 1618) which utilizes the displacement of air by water to blow the pipes of the machine while the water itself turns it and, by moving the organ pipe plugs, plays the tune. This machine, while of little engineering importance does indicate a high level of mechanical ingenuity.



Knife-Switch Mechanism

. . . employs novel pressure-release operation

By Edwin Drewitz
Mechanical Designer
Metropolitan Electric Mfg. Co.
Long Island City, N. Y.

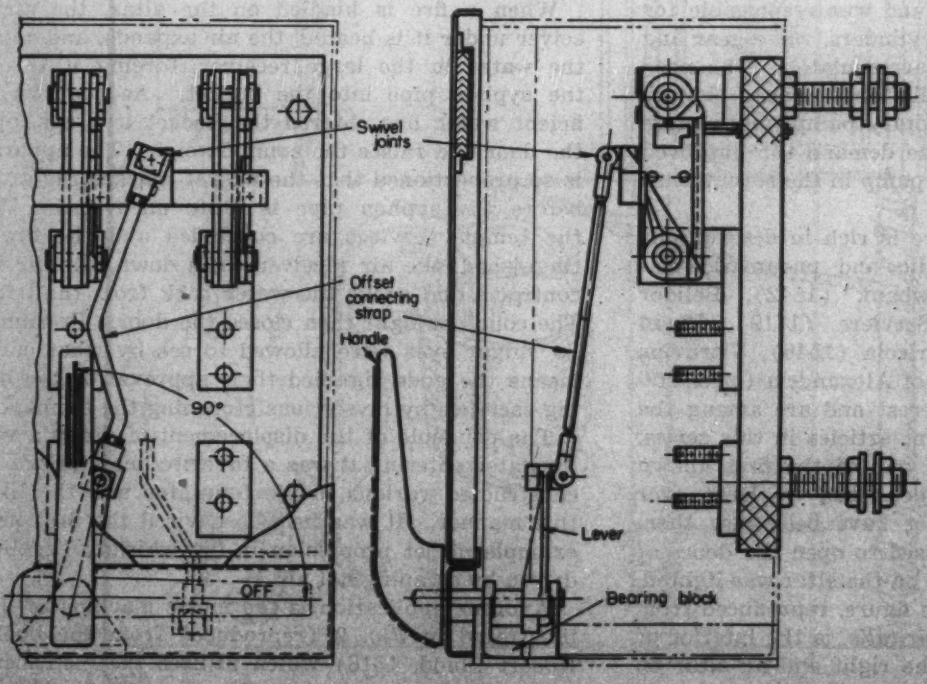


Fig. 1 — Above, left — Closing linkage on this knife switch provides pressure on contacts only when closed

Fig. 2 — Left — View of linkage for switch shown in Fig. 1. Rotation of operating handle opens switch through linkage having strap with swivel joints

Fig. 3—Right — Pressure make-and-break actuating mechanism. The 20-degree slots in the hinge-post pressure pads facilitate loosening the jaw-post screws before the hinge-post screws are turned

DESIGNING actuating mechanisms for knife switches which provide high current capacity and dead-front operation is a challenge to the ingenuity of designers. Beginning at approximately 200 amperes, difficulty with wipe contact of the conventional knife switch is encountered. With progressive increase in current, the blade sizes, contact area and necessary pressure multiply proportionately until the effort required to operate a switch may be beyond the physical capacity of the average operator.

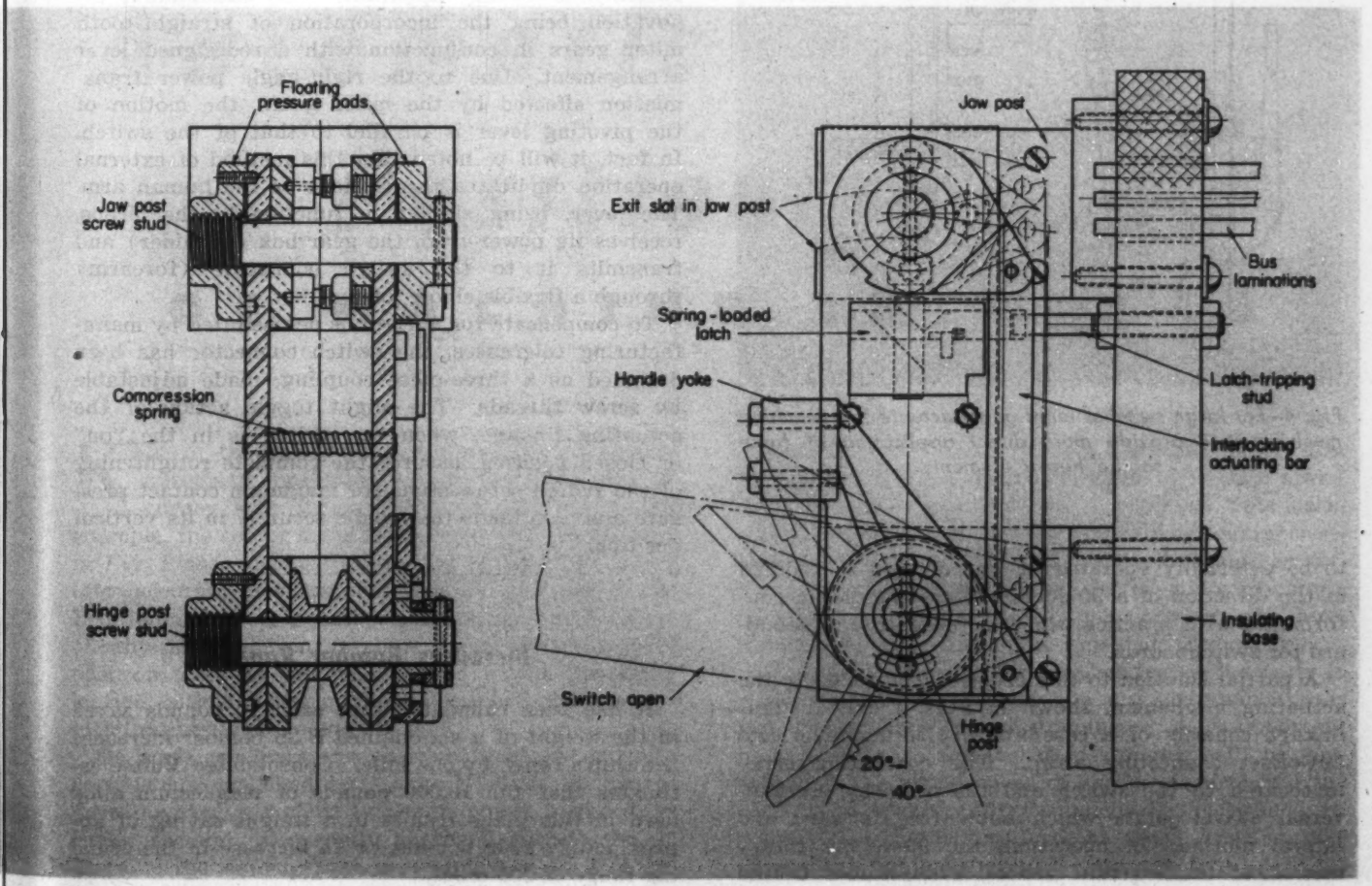
Shown in *Figs.* 1 and 2 is a pressure-release switch which overcomes these problems by mechanically releasing all pressure from its contact surfaces before the switch is opened and, conversely, by applying pressure only after the switch has been closed. This action, which enables manual operation of a large 5000-ampere, three-pole switch, is obtained through the use of screw-tightened pressure pads at both the hinge and jaw posts of each pole, *Fig.* 3. Threaded brass studs (Acme threads) serve as bolts between these cast-bronze pressure pads. The sequence of operations of the screw studs is interlocked with the switch actuating handle.

To remove all pressure from the contact surfaces before the switch blades open, a preliminary motion is broken down into two twenty-degree cycles, each following the other in sequence. Slots in the hinge post castings allow the first twenty degrees of motion to be spent turning the upper screw studs in order to remove pressure from the jaw post first. After the initial twenty degrees, the upper and lower studs are interlocked to act in unison, the jaw post stud receiving another twenty-degree turn to complete its loosening cycle at the same time that the hinge post receives its initial torque.

Thus, the hinge stud receives only a total of twenty degrees of motion in comparison to forty degrees given the upper screw stud. This is done to maintain a desired slight wipe at the hinge post. Upon completion of the initial forty degrees of handle motion, a spring-loaded latching mechanism engages a slot in the jaw-post casting, locking it in place for the disconnect sequence that follows and also preventing the tightening of the jaw post screws before the switch blades are in place again during the reverse closing operation.

After the initial motion of releasing the pressure the switch opens readily. In fact, the pressure-pad actuating bar, which serves to interlock the hinge and jaw posts, *Fig.* 3, assists in ejecting the blades at the jaw post. This is accomplished by having the bar bear against a flat shoulder provided on the upper casting at the same time that the handle is pivoting the blades at the hinge posts.

In closing the switch, the sequence is reversed and the blades, with the pressure device locked by the spring latch, reach their fully closed position before the latch releases and the bolting action takes place. The final throw of the handle then causes the screw studs to retighten and develop thousands of pounds



of pressure on the hinge and jaw post surfaces, locking them securely against the magnetic expulsion forces.

It must also be noted herewith that the pressure-release principle, in addition to providing an easy method of disconnecting high-current circuits, also effects maintenance economies by completely eliminating contact wear and periodic hinge and jaw post realignment.

An interesting design problem presented itself in adapting the original live-front switch for dead-front operation. It was decided to try to avoid redesigning any of the basic live-front switch parts. Economy dictated that interchangeability between all of the live and dead-front switches was to be attained.

The problem then centered itself around developing a sturdy supplementary linkage to couple with and successfully perform the 130-degree forward mation of the live-front switch. Since the switch was

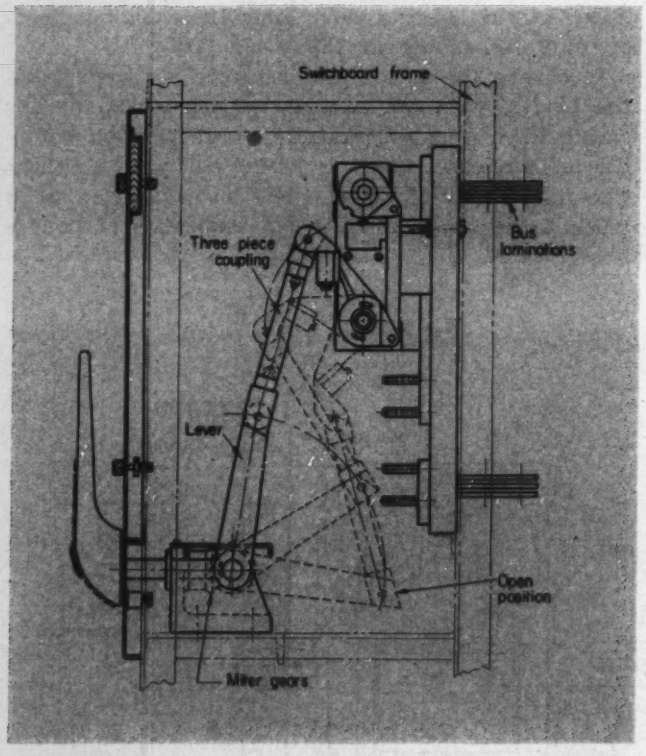


Fig. 4—For large switches miter gears actuate the switching mechanism to provide more direct application of force to the heavy elements

to be externally operated, it was decided to proceed in the direction of a 90-degree rotary handle, in conformance with practice which is recognized as standard for switchboards.

A partial solution to this problem was found in the actuating mechanism shown in *Figs.* 1 and 2. This linkage consists of a cast-bronze pivoting lever and an offset connecting strap. The connecting strap is secured to the switch and the lever by semiuniversal swivel joints which allow free forward and lateral motion. In operation, the 90-degree rotary motion of the external handle is duplicated behind the cover by the pivoting lever which in turn effects a reciprocating motion on the connecting strap to open the pressure switch blades.

The peculiar offset condition of the steel connector is necessitated by the different mounting centers of the handle and the swivel joint on the switch actuating yoke. The handle was located in the center of the switch for appearance while the required electrical clearances between current carrying and non-current carrying metal parts necessitated placing the opposite end of the connecting strap between the switch poles.

This rotary and reciprocating lever combination proved successful and is being used for externally operated pressure switches with current carrying capacities ranging from 200 to 2000 amperes. The added weight of switches larger than the 2000-ampere size, however, posed new problems and made operation by this method increasingly difficult.

To comprehend this new problem, consider a 3000-ampere, three-pole switch in the "off" or open position with approximately eighty pounds of copper blades and heavy actuating mechanism in a nearly horizontal position. Now visualize overcoming the inertia of this heavy mass and lifting it to its vertical closed position with a comparatively short handle, adding to this the resistance offered by the swivel joints due to the increased strain and you will appreciate why a new approach was required.

Solution to this linkage problem for larger size switches is illustrated in *Fig.* 4. Differences between the actuating mechanisms for the larger and smaller switches is readily apparent. The outstanding innovation being the incorporation of straight-tooth miter gears in conjunction with a redesigned lever arrangement. Due to the right-angle power transmission effected by the miter gears, the motion of the pivoting lever is parallel to that of the switch. In fact, it will be noted that this method of external operation duplicates the motions of the human arm. The lever, being similar in function to the biceps, receives its power from the gear box (shoulder) and transmits it to the switch connector (forearm) through a flexible elbow joint.

To compensate for variations necessitated by manufacturing tolerances, the switch connector has been designed as a three-piece coupling, made adjustable by screw threads. The slight toggle action of the actuating linkage, when the switch is in the "on" or closed position, assures the complete retightening of the switch screw studs for maximum contact pressure and also holds the handle securely in its vertical position.

Increases Bomber Range

It has been calculated that each 10 pounds saved in the weight of a six-engined B-36 bomber increases the ship's range by one mile. Consolidated Vultee estimates that the 10,000 pounds of magnesium alloy used in this plane results in a weight saving of approximately 2000 pounds, or an increase in the cruising range of 200 miles.

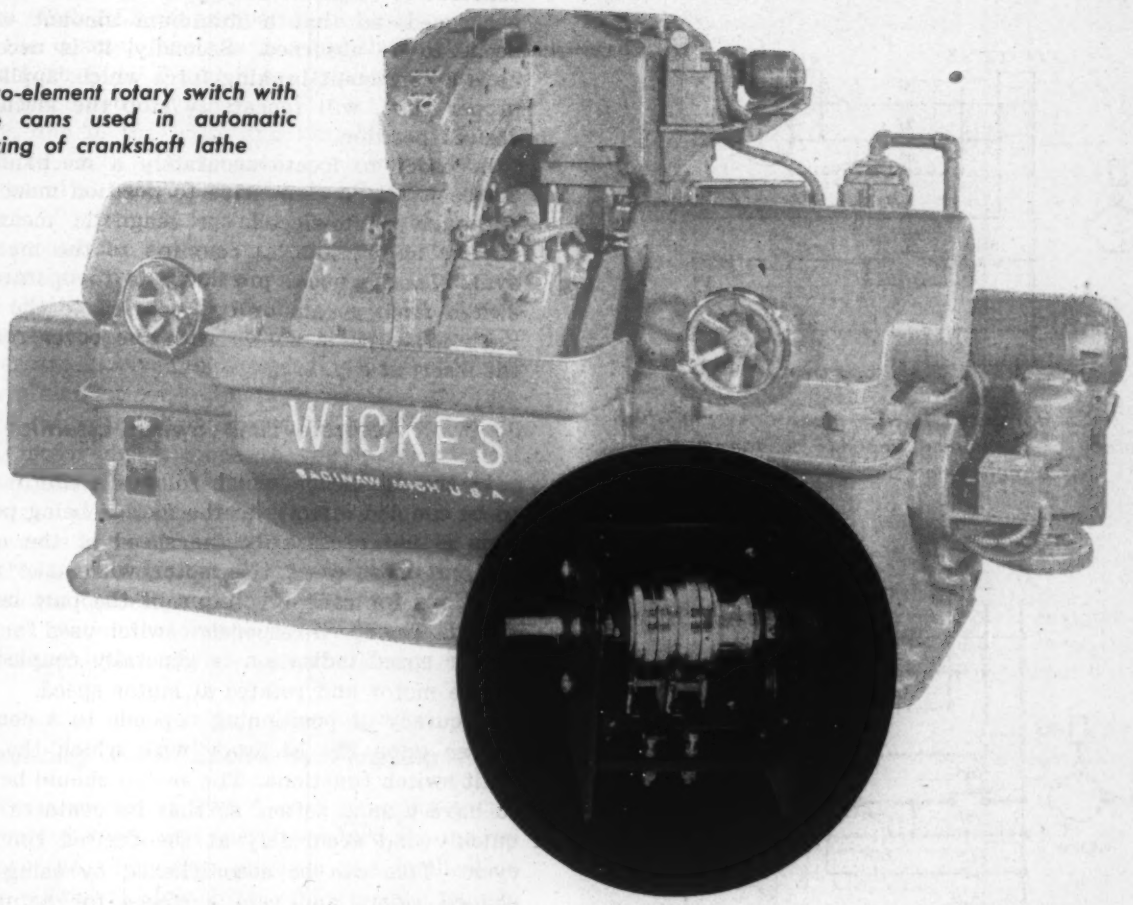


Fig. 1—Two-element rotary switch with adjustable cams used in automatic indexing of crankshaft lathe

Automatic Positioning OF MACHINE SPINDLES

By Robert N. Eck
Engineering Supervisor
Cutler Hammer Inc.
Milwaukee, Wis.

KEY to the outstanding performance of modern automatic machines is often the speed and accuracy with which parts are positioned. For example, the center drive type crankshaft lathe shown in *Fig.* 1 uses automatic indexing to bring the chuck into accurate position for loading and unloading. Positioning, in this article, refers to the stopping of any motor-driven machine in a certain desired position, and the analysis will be limited to rotary motion, although the methods described could be applied to linear motion equally well.

On some machines the positioning of the movable part is accomplished by "jogging", that is, by the operator applying short pulses of power to the drive motor through a specially arranged control circuit. Thus, if the moving part is not allowed to gain appreciable energy, and if there is a braking force either in machine friction or in some form of electric brake, quite accurate "spotting" can be obtained. This method is generally satisfactory where positioning is required only occasionally. However, it is neither sufficiently accurate nor automatic for many machines, especially on production equipment where the positioning function must be repeated frequently.

In order to stop motion, the energy of the parts in motion must be absorbed. On any mechanism it is obvious that the time of stopping or, more important here, the distance traveled in stopping will be governed by the initial speed of the mechanism and the amount of braking effort applied. It is assumed, of course, that the driving force has been removed. Accurate positioning therefore demands first of all, a

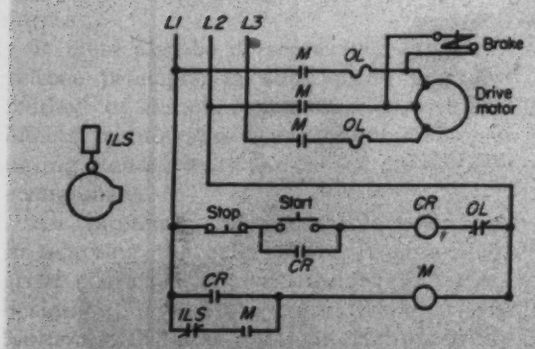


Fig. 2—Control system for low-speed drives, in which accuracy of positioning depends on consistent and accurately timed operation of brake

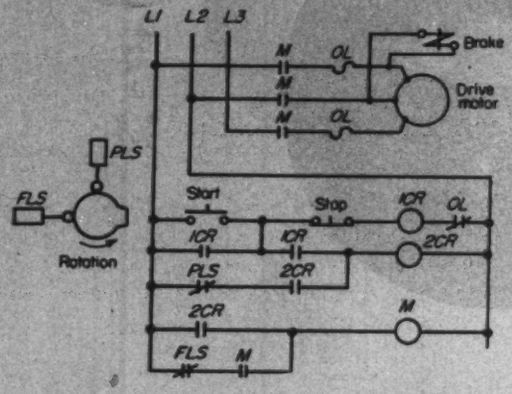


Fig. 3—System providing preliminary slow-down before final index switch will operate, for low-speed rotating spindle applications

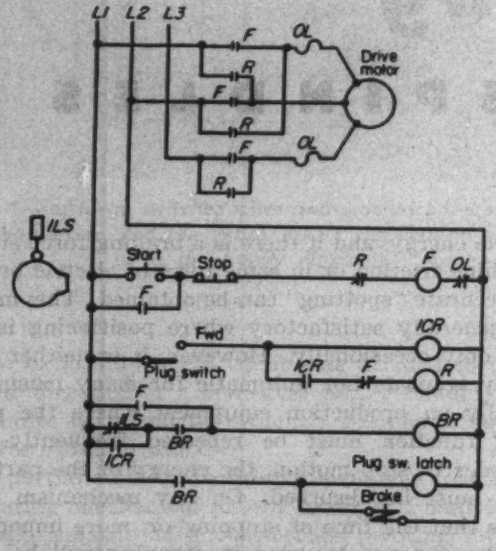


Fig. 4—System using plugging, or application of reverse power to slow motor speed and reduce energy in machine employs speed-responsive switch

constant low kinetic energy in the mechanism to be positioned, so that a minimum amount of energy needs to be absorbed. Secondly, it is necessary to have a consistent braking force which, applied at the proper time, will repeatedly stop the mechanism in desired position.

In order to locate accurately a mechanism some device which is responsive to position must be used. Although photo-electric or magnetic means which require no mechanical coupling to the machine are available, the usual procedure is to operate a limit switch from a cam or dog coupled to the machine. Such a switch is shown with the cover removed in the insert of *Fig.* 1.

Accurate Limit Switch Essential

In the discussion which follows a cam is assumed to be coupled directly to the motion being positioned. This is not necessarily the speed of the motor; in fact, in most cases the motor will make many revolutions for each revolution of the part being positioned. The speed-responsive switch used for plugging or for speed indication is generally coupled directly to the motor and rotates at motor speed.

Accuracy of positioning depends to a considerable degree upon the accuracy with which the indexing limit switch functions. The switch should be designed to have a snap action, so that its contacts will open quickly and accurately at the desired time in each cycle. This can be accomplished by using properly shaped riders and cam surfaces for actuating the switch. It should be pointed out that the positioning limit switch need not necessarily be in engagement with the cam during normal running. By means of a solenoid, the limit switch can be brought into engagement only for the positioning operation. This might be highly desirable from the standpoint of elimination of wear on the limit switch during high-speed running conditions.

A control system which works satisfactorily on low-speed drives is shown in *Fig.* 2. When the stop pushbutton is operated, the control relay, *CR,* drops out but the circuit to the main contactor coil, *M,* is maintained through the limit switch, 1*LS,* and the drive continues under power until the limit switch is engaged by the cam. At that time the power is removed and the brake is set. In this instance, the accuracy of positioning depends entirely upon consistent operation of the brake.

Preliminary Slowdown Desirable

Should the stop pushbutton for the arrangement shown in *Fig.* 2 be operated while 1*LS* is in engagement, the brake will set immediately and a certain inaccuracy from normal operation will result. The shorter the time during which the contacts 1*LS* are open, the less will be this inaccuracy or, if the stopping were always initiated at the instant 1*LS* opened, the positioning would always be consistently accurate.

A method of accomplishing the foregoing is shown in *Fig.* 3. A second limit switch, *PLS,* with an additional control relay, *2CR,* preconditions the stopping and must always function after the stop button is de-

pressed before the final index switch, *FLS*, will be operative. With *PLS* set to operate in a sector ahead of *FLS*, the desired result is accomplished. Circuits shown in both *Figs.* 2 and 3 are applicable only to relatively low-speed drives.

Usually, due to the large and variable amount of energy in the drive to be stopped, some form of slow-down is essential before accurate stopping can be accomplished. Sometimes this slow speed can be obtained by means of a separate indexing motor through gearing and an overrunning clutch. In this case, a control similar to that shown in *Figs.* 2 and 3 could be applied to the indexing motor. Where direct-current drives are involved, slow speeds can be obtained by armature-shunt or adjustable-voltage systems. Slow-down becomes much more of a problem on an induction motor drive, since the characteristics of this type motor are such that any torque which is great enough to cause the motor to run at a low speed will also cause it to accelerate to a high speed very quickly. Nevertheless, the great majority of drives incorporate an induction motor because of its many advantages. Several methods for indexing such a motor-driven machine at low speed will now be described.

Reducing Motor Speed by Plugging

The scheme shown in *Fig.* 4 uses plugging to reduce the motor speed and thereby reduce the energy in the machine. Plugging involves the application of reverse power to slow down or stop a motor. In this case, a speed-responsive switch of the induction disk type, which can be set to open its contacts at some preset low speed, is utilized. At that point the power is removed from the motor and it is allowed to coast. The decrease in speed during this coasting period will depend on the motor load and friction and, if this is low, the first objective of bringing the motion to be indexed to a uniform low speed will have been accomplished. Of course, no more than one revolution of coasting should occur before positioning takes place. Actual stopping of the motor is done in the same manner as *Fig.* 2. When the index switch, 1*LS*, opens, a brake is applied to stop the machine quickly and uniformly.

In *Fig.* 5 the motor is plugged to rest and then allowed to rotate in the reverse direction, with reduced torque obtained by means of primary resistors, until the index switch is operated. One feature of this scheme is that plugging is always initiated at the same position of the work by means of the preliminary switch, *PLS*. By properly locating this switch with respect to the final limit switch, *FLS*, the amount of travel in the reverse direction can be held to a minimum, allowing only for variations in voltage, friction, etc. Thus, the speed of the drive when *FLS* operates will always be low. Here again, final stopping is accomplished by means of a brake.

Reduction of torque by means of the primary resistors must not be so great that under conditions of maximum load the motor will not turn over. It was previously pointed out that if the motor starts it will accelerate; however, in the short travel allowed, it should not reach a high speed before the brake is

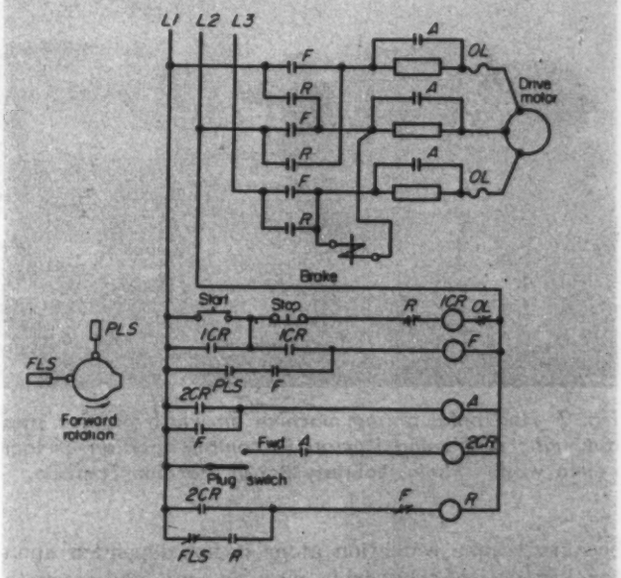


Fig. 5—Control circuit where motor is plugged until stopped and then permitted to rotate in reverse direction until index switch operates

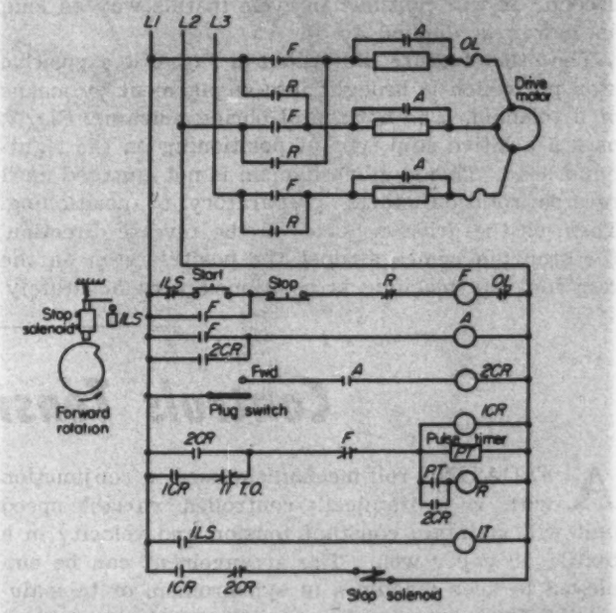


Fig. 6—Circuit in which slow-down is accomplished by plugging, reverse rotation by power pulses. Solenoid-actuated stop pin insures accurate positioning

applied. It is expected that the brake will stop the drive accurately from any reasonably low speed.

The means used for slow-down and for final stopping might be combined in various ways, other than those given for illustration. Two additional features which do not necessarily have to be used together are incorporated in *Fig.* 6. Slow-down is accomplished by plugging, but reverse rotation is obtained by pulses of power, rather than by a steady torque. This scheme will help further in keeping the speed low as the index position is approached. It is particularly useful where rather large breakaway torque is required,

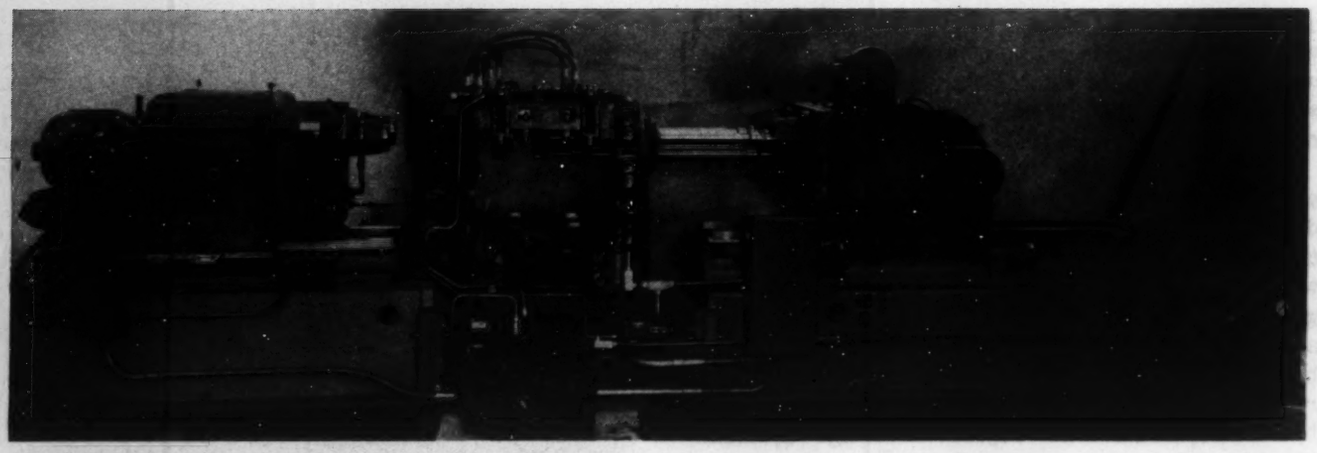


Fig. 7—Horizontal boring machine on which positive stop automatic positioning is used to control insertion of tool into work. Photo, courtesy Baush Machine Tool Co.

because torque reduction alone is not depended upon for low speed. The drive may or may not come to rest between power pulses. The pulse timer which controls this feature can be set, for example, to close its contacts for two seconds and open them for one second. It will continue to cycle in this way as long as power is applied to it.

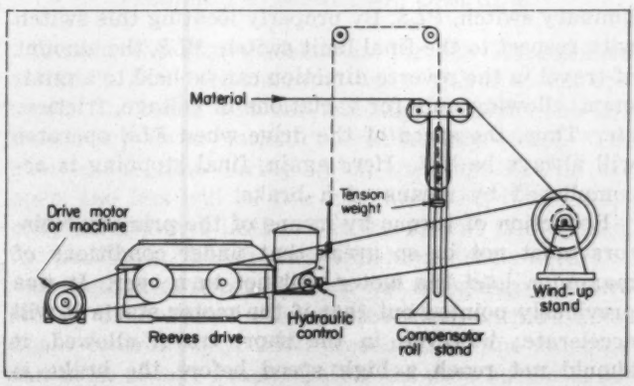
The other feature illustrated in *Fig.* 6 is a positive stop pin which is brought into engagement by means of a solenoid. The horizontal boring machine, *Fig.* 7, uses a positive stop type of positioning on the right-hand head. This stop mechanism is not engaged until reverse rotation starts, preparatory to positioning. Then, as the drive is pulsed in the reverse direction, the stop pin comes against the positive stop on the cam and the machine is positioned very accurately. Limit switch, 1*LS*, on the stop pin indicates when this position is approaching and, in conjunction with a timer, will shut off the power after allowing time for the machine to stall positively against the stop. Upon removal of power, this arrangement provides for the pin to be taken out of engagement, and the machine is then free to be started. In some cases, it might be desirable to have a holding brake to keep the machine in position.

If it is not too severe a shock on the machine, *Fig.* 6 could be modified by having the stop pin fall into a definite slot in the cam, thus 1*LS* could be used to remove power directly without the need for a timed period. Also, this stop could be arranged to keep the machine locked until the next start. As previously stated, variations on all the schemes illustrated should be evident, and may be necessary to incorporate a suitable indexing cycle on any given application.

Controls Tension And Velocity

A FLOATING roll mechanism used in conjunction with a hydraulically-controlled variable-speed unit will maintain constant tension and velocity in a textile or paper web. The arrangement can be employed to keep machines in synchronism or to maintain uniform tension of goods between two machines or two sections of the same machine. Material delivered from one machine passes over a fixed roll, under a floating roll, over a second fixed roll and into the next machine or wind-up drum. The floating roll is connected to the speed-control lever of the hydraulically controlled variable-speed unit.

As shown in the schematic diagram, the unit, made by the Reeves Pulley Co., operates on the principle of constant tension in the web material. The floating roll is preloaded to give a desired web tension, the amount depending upon the material being processed. As the roll increases in diameter, the velocity of the material also tends to increase. This builds up additional tension in the web, causing the floating roll to rise. Upward movement of the floating roll indicates a gradual speed decrease to the variable-speed unit and thereby imparts substantially constant velocity to the web. Since the tension is dependent upon the velocity, the tension also remains constant. The floating roll continuously shifts the hydraulic control to decrease the output speed of the variable speed control unit. Thus, the speed of the wind-up drum is continually decreased as the material builds up in diameter, giving constant tension and velocity on the web throughout the complete process.



PRODUCTION PROCESSES

THEIR INFLUENCE ON DESIGN • PART XLVIII

Die Casting

By ROGER W. BOLZ, Associate Editor, Machine Design

HISTORY of the development of modern die casting as a production process can be traced back more than a century to the first attempts at casting lead bullets before the American Revolution. The first recorded attempt at pressure casting is found in patent papers, dated 1849, covering a crude machine designed for the casting of lead alloy type. It was not until some twenty years later, however, that a machine for making general-purpose castings appeared.

In 1907 the first "gooseneck" hot-chamber die casting machine was patented by Van Wagner. Air pressure was used in this machine to force the metal into the closed die, affording the first step toward uniformity of the product. As machines were improved, the die casting of lead and tin alloys was superseded by the use of zinc alloys from about 1912 on. Aluminum as a die casting alloy was introduced in 1914

but received little attention until the late twenties. The die casting of copper-base alloys entered successful production in the early thirties and adoption of these alloys as well as those of aluminum resulted in the final perfection of the cold-chamber die casting process. In the past few years magnesium alloys have gained importance in this field and now rank next to the aluminum alloys.

DIE CASTING METHODS: As mentioned, there are basically two methods for producing die castings. These have been termed the hot-chamber and the cold-chamber to indicate their primary difference. In general, the hot-chamber method is suited primarily for the casting of alloys having fairly low melting temperatures—in the neighborhood of 1400 F or less—which do not have an affinity for iron. The cold-chamber machine can be used as a substitute for the hot-chamber machine but is especially designed for handling alloys having higher melting temperatures approaching 1800 to 1900 F, for alloys which have an affinity for iron such as aluminum, and for the casting of parts which require the highest possible density.

Hot-Chamber Machine: Earliest method of die casting developed, hot-chamber casting includes all machines wherein the injection cylinder is immersed in a continuously heated pot of molten metal. Molten metal which enters the gooseneck or injection chamber from the pot is forced into the closed dies by direct air pressure, or by a ram which may be actuated by mechanical, pneumatic, or hydraulic means, *Fig.* 1.

The air or gooseneck machine, used mainly for casting aluminum alloys, is limited severely in the pressure which can be applied to force the metal into the dies. Maximum air pressure on the metal is about 600 psi and this pressure is insufficient to exert any great amount of squeeze action for obtaining good density. Production rate on these machines varies according to the casting size but does not often exceed 110 shots per hour.

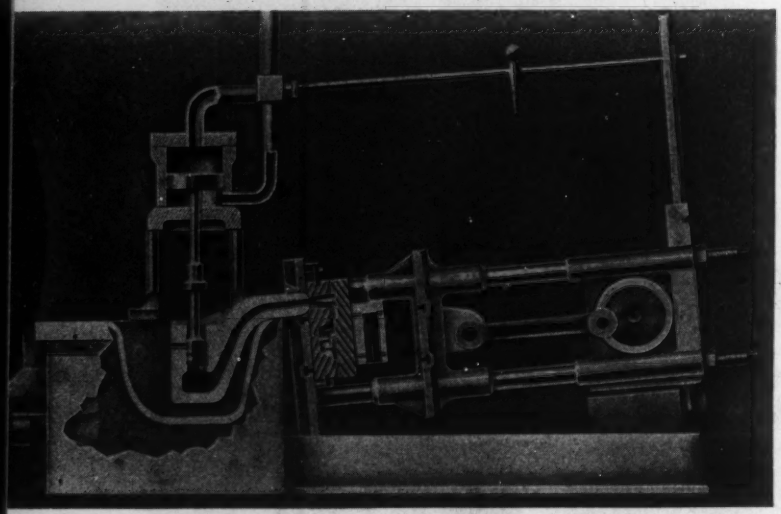


Fig. 1—Above—Hot-chamber die casting machine sectioned to show method of injection

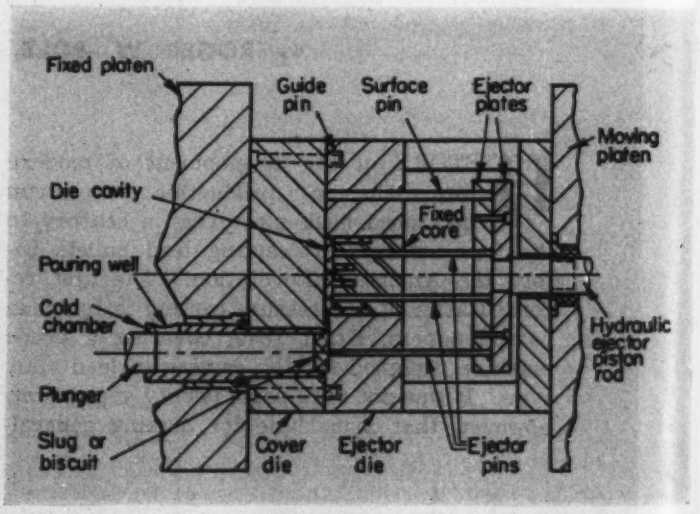
Fig. 2—Below—Cold-chamber die casting machine shown in production of large electric cleaner castings

Plunger Machines Widely Used

Plunger hot-chamber machines, *Fig.* 1, generally operate with pressures ranging from 1500 to 6000 psi and are used for casting alloys of zinc, lead, antimony, and tin. Production rate, depending upon the size of the machine, ranges up to a maximum of 750 shots per hour.

Cold-Chamber Machine: Operation of the dies in cold-chamber casting is identical to that found in the hot-chamber method. Major differences between the two methods are in the means for injecting the metal and in the pressures used. In cold-chamber machines, *Fig.* 2, the pot of melted metal is separate from the machine and the required amount is ladled into the plunger chamber, *Fig.* 3, and from thence

Fig. 3—Cross section through dies and injection plunger of typical horizontal cold-chamber machine



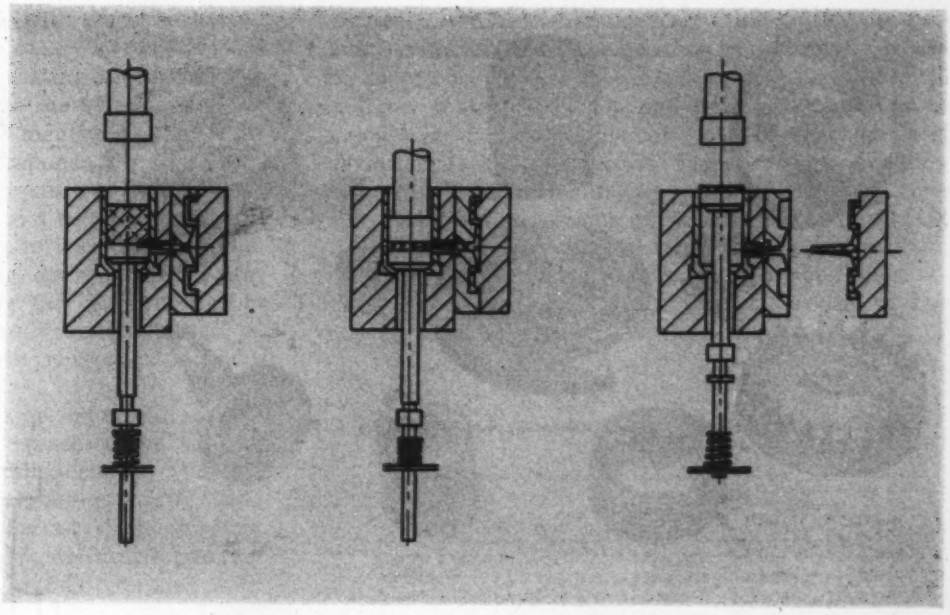


Fig. 4—Cross sections showing casting sequence with typical vertical cold-chamber die casting machine

squeezed into the die cavities. The latest machines available now offer automatic ladling of the metal into the chamber.

Pressures generally used for casting may range from about 6000 to as much as 37,500 psi although some modern high-presure machines are capable of producing pressures from 50,000 to 100,000 psi on the metal.

Cold-chamber machines are normally produced in horizontal and vertical models. In the horizontal machine the metal is injected from a horizontal cylinder, *Fig.* 3, whereas in the vertical machine the injecting cylinder is upright, *Fig.* 4. Vertical machines available are capable of rates ranging from 60 to 300 shots per hour depending upon the size of the casting being made. Horizontal models available are capable of rates up to approximately 400 shots per hour or more.

Wide Range of Sizes Practical

Size of Castings: Practical range of casting size and weight depends greatly upon the available production casting equipment. Generally, minimum casting weight in zinc or copper-base alloys is something less than one-half ounce. Castings in aluminum or magnesium alloys weighing but a fraction of an ounce are also possible. Maximum weights of castings which can be produced on standard machines are shown in TABLE 1 which covers the common categories of die-casting alloys.

In size, magnesium diecastings are limited to those with a maximum dimension in one direction of about 36 inches. In aluminum alloys, *Fig.* 5, the maximum size is generally set at an overall of about 36 by 12 by 9 inches although castings up to 84 inches long and over 1200 square inches projected area are on record. The majority of production castings, however, seldom exceed five to ten pounds in weight or maximum dimension of 24 inches overall.

Production: Owing to the high-capacity output of

Fig. 5—Group of aluminum-alloy diecastings showing range of designs and intricacy

die casting machines, small quantities of parts are seldom economical. Where quantity requirements are relatively high and design is suitable for the process, lowest possible cost can be achieved. The lowest practical production quantity which will justify use of die casting ranges from 1000 to 5000 pieces depending upon the particular design of the part to be cast and the metal to be utilized.

Production cost is also tied in closely with the metal

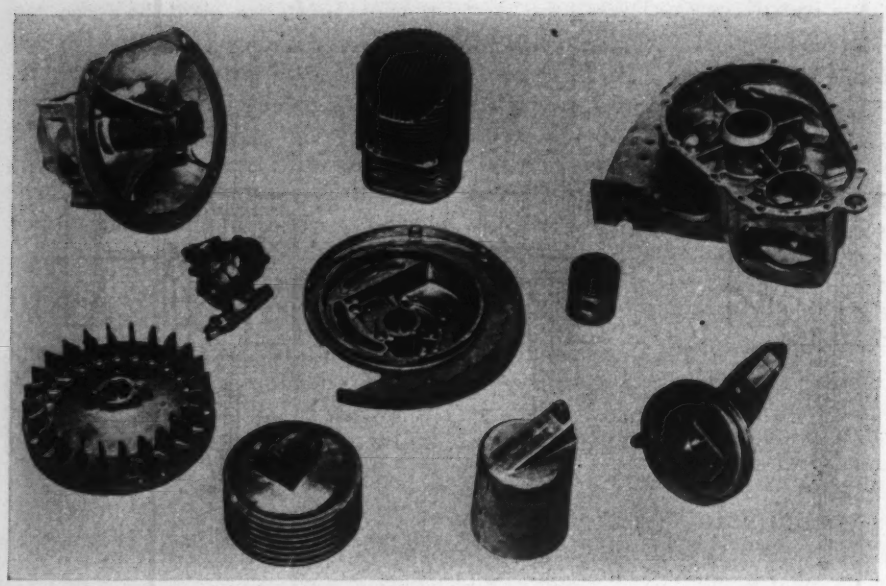


Fig. 6—Left—Group of aluminum-alloy diecastings used in McCulloch gasoline engines

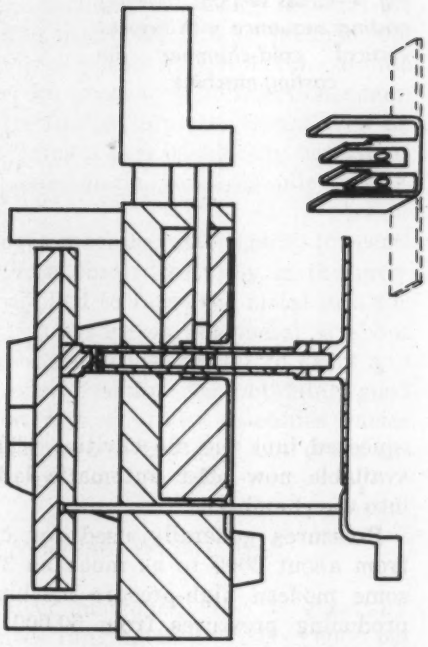


Fig. 7 — Right — Simple cavity in one die half is possible with this part which is bent to shape after casting. Coring would be difficult or impossible otherwise

to be cast. Useful die life in casting varies with the melting point of the metal. Die life with copper-base alloys, which usually are cast at 1750 to 1800 F, ordinarily is expected to run from 10,000 to 75,000 or more fillings. Core life with the same dies is lower, ranging from 6000 to 20,000 shots generally. Die life when casting aluminum alloys is better, the lower melting point—1065 to 1165 F—permitting 100,000 to 250,000 fillings. Zinc alloys are normally cast at 750 to 800 F and die life at this temperature is maximum—up to one million or more shots are possible.

Production is also determined to a degree by the type of die. Depending upon the type of part and its size, multiple-cavity dies can be used. From two to 30 or more cavities can be filled at one shot.

Pressure-Mold Castings: Developed as a result of war demand for mass production, pressure-mold castings are in reality premium-quality diecastings. Pressure-mold castings are produced by the cold-chamber method using high-pressures. Produced under SAE Specification AMS 4292 (AAF 11347), these castings are made only in aluminum alloys A13 (Alcoa), A43, A360 and A380 (iron in excess of 0.6 to 0.8 per cent

Table 1—Maximum Weight and Area of Diecastings*

Alloy	Weight (lb, max.)	Projected Area (sq. in., max.)
Copper-base	20†	250
Aluminum	30	625
Magnesium	20	625
Zinc	35	800

* Maximum values for standard equipment. In special cases and with special machines these values have been exceeded.

† Standard machines are capable of injecting up to 40 pounds of copper-base alloys but practical considerations such as hand ladling and heat dispersal with such large volumes make their use uneconomical and sometimes impractical. Certain manufacturers do not consider that more than 14 pounds in copper-base alloys can be economically die cast until improved die steels are available.

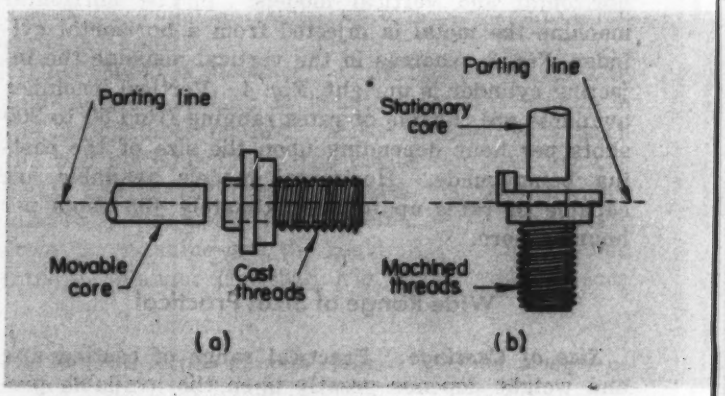


Fig. 8—Movable core is necessary with the threaded part (a) whereas a stationary core can be used with (b). In vertical casting, (a) would be favored owing to denser metal as air would be entrapped with die (b)

not permissible) under x-ray control and must exhibit strengths which are not less than 75 per cent of test-bar values. Multiple-cavity dies cannot be used and design limitations are more severe than for commercial quality diecastings to insure maximum soundness.

DESIGN CONSIDERATIONS: To achieve the maximum benefit from die casting methods, it is necessary to observe certain rules which avoid costly or impossible die designs. Because permanent steel dies are used, it is obvious that parts must follow many of the same

design limitations characteristic with permanent-mold casting.

Design possibilities with die casting are almost unlimited, parts produced by these methods since their inception are too numerous to mention. Typical of present-day use of die-cast components are the engine parts shown in *Fig.* 6. As can be readily recognized, lowest possible die cost and consequently part cost are obtainable by adhering to maximum simplicity in design. The greater the quantity to be produced, however, the greater are the opportunities to utilize complex die designs to cost advantage in eliminating machining and other subsequent production operations.

Parting Lines: To eliminate as much die sinking as possible the parting line or place where the die halves separate should be established on a single plane parallel to the surface of greatest length. This also permits ejection of the part over the shortest possible distance, a feature which facilitates production of satisfactory castings.

Flash Trimming Important

Establishment of the proper plane of parting may often depend upon design features, the die casting machine used, die operation, tolerances, metal soundness, etc. It is desirable to visualize the final design result to determine the problems which may result from the normal flash which occurs at the parting line. Seldom should the parting be established at a sharp corner; it is much simpler to trim flash if it occurs just slightly below an edge which can be rounded. Frequently a bead can be used at the parting line and such design makes flash removal a simple, neat operation. Only where a part can be completed in one half of a die, *Fig.* 7, or where final machining operations can be utilized for flash removal should sharp-edge partings be considered.

Where close tolerances are desirable without recourse to additional finishing operations, the parting plane may be critical. It is often desirable to locate close-tolerance portions so as to be produced in the solid portion of one half of the die rather than between the two halves. An additional consideration is with pieces cast into the lower half of the die on a vertical machine; where strength and density are primary considerations, the parting line normally would be placed to avoid trapped air and porosity, *Fig.* 8.

When costly die slides and movable cores can be avoided by use of irregular or "joggled" parting lines, deviation from the rule of flat partings can often be highly economical in die cost or production time and perhaps both. Such a case is shown in *Fig.* 9.

Draft: To assure ready removal of castings from the dies, draft is required for all portions substantially normal to the parting line or parallel to the line of die movement. The same is true of cores or slides. Typical draft values normally employed for various materials are tabulated in TABLE 2. Minimum values are shown in the table but where function and design permit, greater drafts should be allowed. Generous drafts extend die life considerably by eliminating to the greatest extent possible natural core and die wear. The poorer the bearing qualities of the metal the more important generous draft becomes. Generous draft permits easier withdrawal, eliminates possible distortion in removal and assures the best surface quality obtainable. For ribs of ⅛-inch or greater thickness, a minimum draft of 3 degrees is

Table 2—Approximate Draft Values for Die-castings

(Minimum, inches per inch of length per side)

Alloy	Side Walls[1]	Cores[2]	
		Depth	Diam.
Copper-base	0.015–0.020	0.015	0.015
Aluminum	0.008–0.010	0.006[3]	0.001
Magnesium	0.0025	0.003[3]	0.0005
Zinc	0.002–0.005	0.003	0.003
Lead and Tin-Base	0.010	0.0005	0.0005

[1] Greatest draft possible should always be used to reduce die wear, especially where metal shrinkage would interfere in withdrawal.

[2] For cored holes through hubs and bosses where metal shrinkage may be severe, a draft of 3 to 5 degrees or more should be allowed. Depth of hole or core length values apply per side and are minimum for cores under 1 inch in diameter. Values for diameter apply per inch of diameter over 1-inch and are added to the basic value for core length.

[3] Holes under 1 inch require greater draft; for instance, ⅛ to ¼-inch holes should have 0.008-inch for aluminum and 0.004-inch for magnesium per inch of length per side, minimum, and 1/10 to ⅛-inch diameters, 0.010-inch for aluminum and 0.005-inch for magnesium per inch of length per side, minimum, and 0.025-inch per inch of depth in magnesium and double the amount for aluminum.

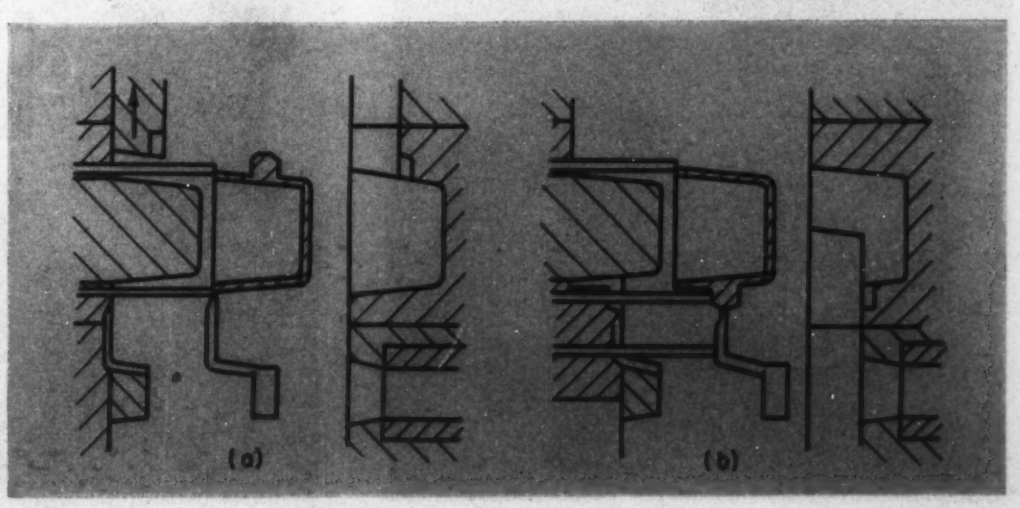


Fig. 9—A change in design and parting line for this casting eliminates a slide (a) and permits production of a central projection (b)

desirable. Where narrower ribs are necessary, as much as 15 degrees of draft per side may be required.

Wall Sections: As is generally true in the design of all castings, wall sections should be as uniform as possible. Uniformity of wall thickness is extremely important and should be adhered to closely to avoid undue shrinkage variations and warpage. Where walls must vary somewhat, gradual blending should be used to make satisfactory transitions. A good rule is to make the length of tapered section greater than four times the difference in wall thicknesses. To permit the most rapid cooling and, hence, casting cycle, the lightest wall feasible is generally recommended. In general, the walls of diecastings should fall within the practical range of 1/16-inch to 5/16-inch. Extremely heavy walls will result in voids and porosity. The limits of wall dimensions generally practicable in the die casting of various alloys are shown in TABLE 3.

Shrink Avoided by Design

Where concentrations of metal such as bosses or heavy ribs are utilized, the unequal shrinkage compared with that of adjacent thin walls results in some shrinkage on the wall surface. These shrink marks or "shadow-hollows" may be undesirable and in cases where the metal volume cannot be reduced, the shrinkage can often be masked by low ribbing or low-relief designs. As a rule, shrink marks seldom occur with walls over 0.100-inch in thickness.

Large, plain flat walls should be avoided wherever a perfect, unblemished area is desired. To eliminate the cost of rejects from imperfections natural in such surfaces, it is recommended that they be crowned, curved, or broken up by beads, steps or low relief.

Coring: To assist in attaining uniformity of section as well as for providing holes, coring is widely employed, *Fig.* 10. Use of cores as "metal savers" and to provide uniform walls in a casting assures maximum economy in design and eliminates heavy portions which are inherently subject to shrink porosity which reduces overall strength.

Fixed cores which form an integral part of the die halves and have axes parallel to die motion are least expensive and produce the most accurate results. It is possible, however, to utilize movable corepieces which slide on or within the dies. Large, deep holes should almost invariably be cored for maximum economy but small holes can often be drilled or punched with equal or better economy. Holes may be designed in almost any relationship, *Fig.* 11, but where multiple-cavity dies are used, the number of sides from which cores can be applied is distinctly limited.

For maximum core life, the diameter-to-length ratio should be kept small. Large cores withstand the heat and mechanical abuse much longer than small ones. Generally, cored holes can be designed to have depths up to five times the diameter in zinc, lead or tin-alloy castings and up to three times the diameter in aluminum, magnesium or copper-base alloys. These depths are based upon the minimum draft allowable. With holes over ¼-inch where a more

Table 3—Section Limits for Diecastings

(inches)

Alloy	Wall Section Thickness		
	Min Small Parts	Min Large Parts	Maximum
Copper-base	0.031	0.062	0.500
Aluminum	0.040	0.080	0.500†
Magnesium	0.031*	0.062	0.500†
Zinc	0.015	0.050	0.500‡

* Where area to be cast does not exceed 10 sq in. Practical section thickness for walls up to 0.130-inch is usually set at approximately one-thousandth the projected area to be cast.

† Sections greater than 0.150-inch are rarely required.

‡ Sections up to 1½ inches have been cast and are satisfactory where some voids are permissible. Walls over ½-inch are rarely economical.

Fig. 10—Outboard motor cylinder block cold-chamber die cast from aluminum with steel cylinder wall inserts

Fig. 11—Group of copper-base alloy parts showing deep recesses and intricate coring obtained by means of punches

generous draft can be used, say 0.025-inch or more per inch per side, lengths of cored hole up to eight and occasionally ten times diameter can be produced. Where the core can be supported on both ends these

Table 4—Minimum Core Diameters
(inches)

Alloy	Diameter
Copper-base	3/16
Aluminum	3/32
Magnesium	3/32
Zinc	1/32

depths are more easily and economically obtainable. With adequate support even longer holes have been produced. For instance, in a die cast magnesium manifold in which a series of outlet ports permitted support from side cores, a hole 0.218 to 0.299-inch in diameter by 10.750 inches long has been successfully cast in production. The approximate minimum size of core which can be used with various materials is shown in TABLE 4.

Cores which intersect or form a joint in a part are feasible, *Fig.* 12, but often may form a flash which cannot be readily removed. Collapsible core-pieces can be used to produce special holes not otherwise possible to cast but are seldom economical.

Corner Radii and Fillets: Wherever possible, outside corner radii of parts should match internal fillet radii to maintain uniformity of section. If sharp outside corners must be used, a minimum radius of 0.015-inch should be specified for economy. Because it is difficult to sink a sharp corner into a die (other than those produced at the parting line), it is recommended that such corners be rounded and that the radius never be less than 1/16-inch. The top edges of ribs and webs should be generous and a full radius is desirable wherever possible, *Fig.* 13.

Sharp internal corners in diecastings (external corners in dies) are detrimental. Fillets facilitate the flow of metal in the dies and lengthen the die life considerably. To avoid overlarge fillets which may create shrink voids, a general formula has been recommended: Make the radius approximately equal to one-third the sum of the two adjacent wall thicknesses. With magnesium diecastings, however, an exception exists and generally fillet radii should be equal to the sections joined.

Bosses: Since in diecasting design the lightest possible walls are desirable, it is generally necessary to provide bosses or hubs at points in the part where fasteners are to be used or mating parts positioned, *Fig.* 14. Minimum wall sections practical should be used and where additional strength or rigidity is desired, reinforcing ribs can be used along with bosses. Such ribs also facilitate metal flow to the bosses. Wherever possible, all bosses should be on the same side of the casting to aid adherence to one die half for ejection.

To accommodate fasteners, bosses may be tapped from a cored hole. Boss and hole location will be accurate and the usual countersink for tapping can be incorporated with the core. Where cores are not advisable or practical, it is possible to provide drill-points where such are deemed desirable.

Recesses to be Avoided

Recesses: All design innovations which will eliminate any recessed or undercut portions in the direction of die or core travel should be explored thoroughly prior to use of such details. Undercut and recessed portions can only be formed with expensive dies and as a result of complexity, useful die life is also shorter. Though recesses can be formed, economy is best served by design to eliminate them wherever possible.

Where external undercuts are at right angles to the parting line, a stationary core in the die can often be used by judicious selection of a parting line. Where the recess interferes with parting or falls at right angles to the line of die travel, a slide or core is usually required, *Fig.* 9. Internal undercuts are most difficult and normally necessitate the use of loose pieces, "knockouts" or collapsible cores.

Fig. 12 — Below — Cold-chamber aluminum carburetor diecasting shows intricate intersecting coring utilized

Fig. 13 — Right — Gasoline engine cylinder head showing thin, closely spaced ribs as cast requiring no machining

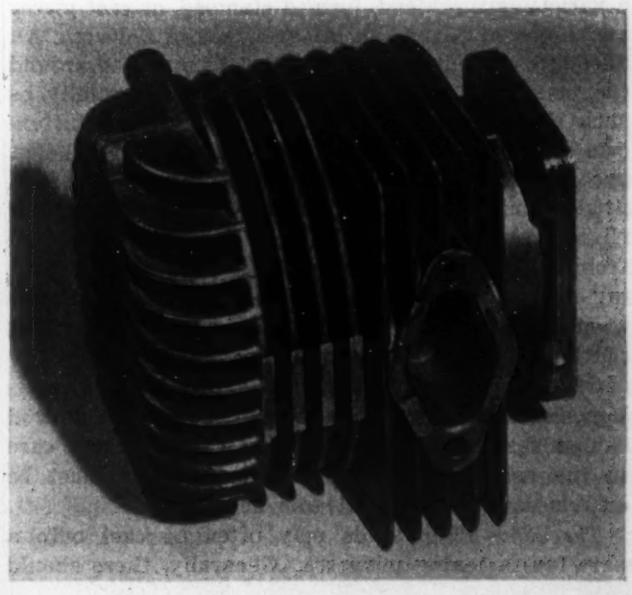


Table 5—Selector for Die Casting Alloys*

Selection Factor	Aluminum Alloys ASTM Nos. 5, 7, 12	Copper Alloys (Brass)	Magnesium Alloys ASTM Nos. 12 and 13	Zinc Alloys ASTM Nos. 21, 23, 25
Mechanical Properties				
Tensile strength	3	1 (strongest)	3	2
Impact strength	3	1 (toughest)	3	2
Elongation	4	1 (most ductile)	3	2
Dimensional stability	2	1 (most stable)	3	3[a]
Resistance to cold flow	2	1 (most resistant)	2	3
Brinell hardness	3	1 (hardest)	3	2
Corrosion resistance	3	1 (most resistant)	4	2
Physical Constants				
Electrical conductivity	1 (highest)	2	3	2
Thermal conductivity	1 (highest)	2	4	3
Melting point[b]	2	3 (highest)	2	1 (lowest)
Weight, per cu in.	2	4	1 (lightest)	3
Casting Characteristics				
Ease, speed of casting	2	3	2	1 (easiest)
Maximum feasible size	1	2	1	1
Complexity of Shape	1	2	1	1
Dimensional accuracy	2	3	2	1 (most accurate)
Minimum section thickness	2	3	2	1 (thinnest)
Surface smoothness	2	3	2	1 (smoothest)
Cost				
Die cost[c]	2	3	2	1 (lowest)
Cost per pound	2	4	1	3
Production cost	2	3	2	1 (lowest)
Machining cost	2	3	1	1
Finishing cost[d]	3	2	3	1 (lowest)
Cost per piece[e]	2	3	2	1 (lowest)
Use				
Extent of application	2	4	3	1 (most used)

* Courtesy New Jersey Zinc Co.

[a] Through the use of a low temperature annealing treatment, Alloy No. 23 can be made virtually stable in dimensions.

[b] A low melting point is favorable in reducing die cost and upkeep and facilities casting.

[c] Dies for casting the low melting point alloys are least expensive and have longest life.

[d] Includes polishing and buffing expense as well as ease of applying all types of commercial finishes, both electrodeposited and organic.

[e] Based on die, material and fuel costs, production speed and machining and finishing costs.

These should be avoided if at all possible and ordinarily are only feasible where quantity permits the additional die cost. The most economical method for obtaining internal reliefs or grooves without resorting to expensive collapsing punches is by use of inserts. Die-cast rings of proper design can be slipped onto the punch and cast into place, *Fig.* 15. Owing to the chill effect from the punch, the insert does not adhere and can be machined out in a simple operation.

Inserts: The use of cast-in inserts extends also to a variety of machined, formed stamped, or cast pieces which are to become an integral part of a design. An adequate amount of material must be provided around the insert for support and design should usually be such that solidification contraction of the metal exerts the desired locking force. Heavy knurls, holes, grooves, slots or other grip surfaces are desirable. Studs should be designed to have a shoulder surface slightly above the cast metal to eliminate edge flash from entering the threads and the possibility of pulling out under load. Wherever possible a flange shoulder should be used on the stud to permit sealing off the metal and to add strength.

Often, where coring is impossible, special diecastings, tubes, etc., may be cast-in to achieve the desired design result. Where inserts are to be used, care in the selection of material combinations must be exercised to prevent galvanic action.

Threads: Plain studs may often be cast onto a part for fastening purposes. Generally, these should be left plain and riveted or gripped with a fastener which requires no threads. Threaded cast studs are generally weak. External threads under ¾-inch as a rule must be machine threaded, cast threads rarely being economical. Generally, where threads are coarser than 24 pitch and over ¾-inch in pitch diameter, casting is feasible. Where external threads can be cast split across a parting line, cost is not increased but *is* where a loose piece must be inserted

Fig. 14—Intricate vacuum cleaner aluminum casting weighing about five pounds. Thin walls, bosses, drillpoints, and ejector locations are easily discernible

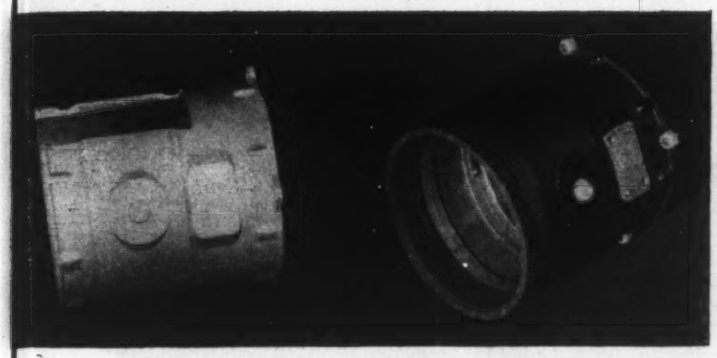


Fig. 15—Section through a flight instrument housing shows insert of same alloy as housing die cast in place, left. Right, assembly shows smooth internal groove obtained by removal of insert by machining

and removed from each casting to form a flashless thread.

Markings: Wherever any type markings are desired on diecastings the specification should be for raised design. Depth of markings should not exceed their face width, a ratio of 1.5 to 1 in depth to face width being an economical maximum. Depressed lettering on the casting requires exceedingly expensive die work. Lettering, of course, should occur only on surfaces parallel to that of the parting line to avoid special slides for ejection. Draft angle for lettering or markings should be 20 degrees or greater.

Ejector Locations: A variety of means are used to permit rapid, positive ejection of castings from the die cavities. Most commonly used are ejector pins, *Fig.* 3. Although the designer will seldom know where ejectors are to be used, it should be kept in mind that wherever such pins occur in the die face a flash will result. Any surface which must be free from such marks should be so indicated. Occasionally, special ejector lugs are cast onto a part to permit removal without marking or deforming. The result of ejectors can be seen in *Fig.* 14.

Premium-Quality Casting Design

Pressure-Mold Castings: The design of pressure-mold diecastings follows closely that of ordinary commercial castings except that uniformity of section is imperative. Design must avoid any details which induce undesired turbulence and general design must be simple as possible. Conditions such as sharp corners, raised lettering, cast-in inserts, cores in the path of the gate entry, and cast threads except opposite the gate are not acceptable. Maximum section is $\frac{1}{8}$-inch, except in special cases.

MATERIALS: Although alloys of lead and tin can be readily die cast, they seldom find application in machine design. Modern zinc alloys, which are die cast at 750-800 F, find the widest usage in general design where minimum weight and high-temperatures are not important factors. Strength of zinc alloys is higher than that of any other die casting alloys except the copper-base alloys. Zinc alloys can be readily finished by almost any commercial method. Use at temperatures above 300 F is not recommended.

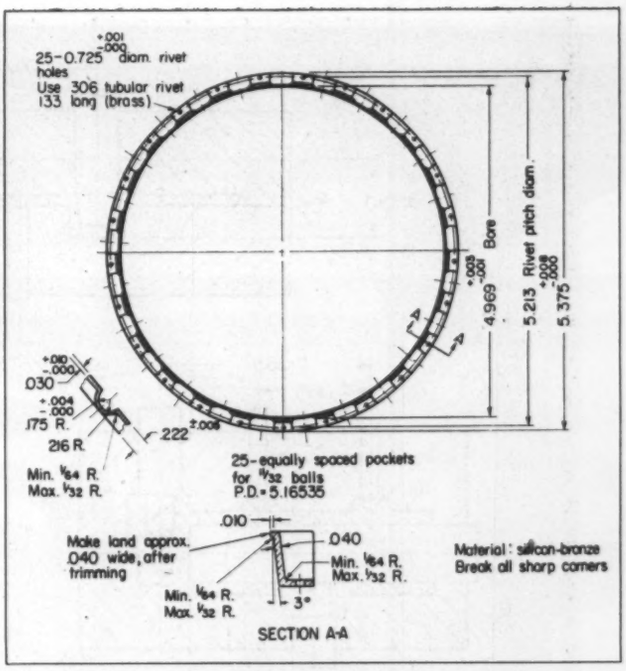


Fig. 16—Unusual ball retainer for an antifriction bearing die cast in silicon-bronze alloy

Contact with steam or water generally results in breakdown.

Owing to higher melting temperatures, aluminum, magnesium and copper-base alloys are more expensive to cast than zinc alloys, generally in the sequence shown. Aluminum and magnesium alloys are very stable and most often are selected for low-weight applications, for cases where temperatures over 300 F are encountered, or for corrosion resistance.

Copper-base alloys offer maximum strength parts but have the adverse characteristic of a high melting point. Die life is short and surface quality of castings is not as good as with the other alloys. Owing to the fact that less overall heat is dispersed through the die, castings with average or light walls are most economical to cast, *Fig.* 16. Copper-base alloys are utilized primarily for castings where strength, hardness, or corrosion resistance are important in design. Ordinary die casting brasses or bronzes afford tensile strengths ranging up to 85,000 psi. The aluminum bronzes increase this range to around 100,000 psi. The silicon bronzes, though lower in physicals, have the highest castability and are used where thin sections must be filled.

Comparator data in TABLE 5 are presented in

Table 6—Diecasting Tolerances*
(Minimum, plus or minus)

Alloy	One Dimension (inch per inch)	Minimum Total (inches)
Copper base	0.003	0.005
Aluminum	0.0015	0.002
Magnesium	0.0015	0.002
Zinc	0.001	0.0025

* Tolerances apply to dimensions formed within cavities of solid dies. Dimensions affected by die parting line or moving parts require an additional tolerance of plus 0.003 to 0.010-inch.

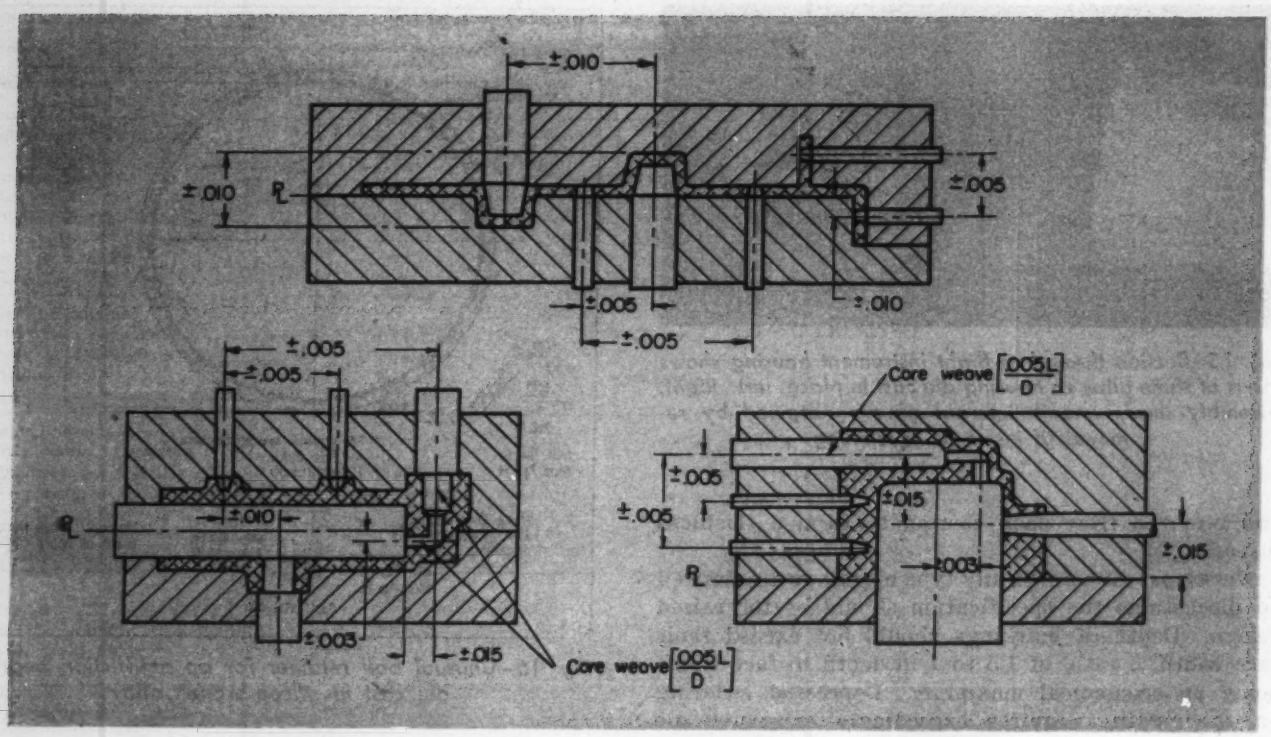


Fig. 17—Diagrammatic sketch showing average production tolerances that can be maintained with aluminum die casting. Tolerances for zinc are about half these values and for copper-base alloys, about double

order to show the general factors for selection.

TOLERANCES: Generally, die casting offers closer dimensional tolerances than any other production casting process producing comparable results. As is true with any design, tolerances should be held to a minimum only on the dimensions which so require. Longer die life and greater economy result where generous tolerances are possible.

On fractional dimensions which are not critical, a total tolerance of plus or minus 0.010-inch is generally assured on lengths up to about 6 or 7 inches or 0.0015-inch per inch over 7 inches and need not be indicated. Closest tolerances can be held on portions which are formed within solid portions of a die. Dimensions across the die parting line are normally about double. Average commercial tolerances for die castings of various materials are shown in TABLE 6. In *Fig.* 17, tolerances are depicted for various commonly encountered die arrangements. The tolerance on flatness of surfaces is generally obtained by the formula $0.0015x$, where x is the longest dimension of the flat surface, in inches.

Some warpage occurs in die casting both on ejection from the die and on cooling. Where heat affected metals such as magnesium are cast, warpage ordinarily does not exceed 0.005-inch per linear inch or more than 0.015-inch total in any dimension of 8 inches with a minimum to be expected of 0.005-inch.

Smoothness of surfaces on die castings depends greatly upon the metal cast and especially its melting temperature. Low melting metals such as zinc produce castings with excellent surfaces which require little and, in some cases, no special finishing. Up through the aluminum and magnesium alloys surface finish or roughness to be expected in commercial runs of castings ranges from 40 to approximately 100 microinches, rms. To assure the smoothest surface on all exterior portions of a casting, it is recommended that a draft of at least 5 degrees be specified.

With the higher melting point metals surface roughness is somewhat greater owing to heat checking of the die surfaces under the enormous pressures utilized. With new dies copper-base die castings have surfaces equal to or better than that found in permanent-mold casting. However, as dies are used and heat checking results in fine cracks in the die surfaces, the metal is forced under pressure into the cracks and results in corresponding raised veins on the casting surfaces. Ordinarily these veins can be removed with an average amount of polishing.

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Aluminum Co. of America (Fig. 5) ..... Pittsburgh, Pa.
American Magnesium Corp. ..... Cleveland, O.
Dow Chemical Co., Magnesium Div. ..... Midland, Mich.
Harvill Mfg. Co. (Figs. 7, 9 and 17) ..... Corona, Calif.
Hydraulic Press Mfg. Co. (Figs. 2, 3, 10, 12, 13, 14) ..... Mount Gilead, O.
Hydropress Inc. (Fig. 4) ..... New York, N. Y.
Jack & Heintz Precision Industries (Fig. 15) ..... Cleveland, O.
Kux Machine Co. ..... Chicago, Ill.
Lester-Phoenix Inc. ..... Cleveland, O.
McCulloch Motors Corp. (Fig. 6) ..... Los Angeles, Calif.
McGill Mfg. Co. (Fig. 16) ..... Valparaiso, Ind.
Miller & Taylor Tool Co. ..... Cleveland, O.
Milwaukee Die Casting Co. (Fig. 8) ..... Milwaukee, Wis.
New Jersey Zinc Co. ..... New York, N. Y.
Reed-Prentice Corp. ..... Worcester, Mass.
Titan Metal Mfg. Co. (Fig. 11) ..... Bellefonte, Pa.

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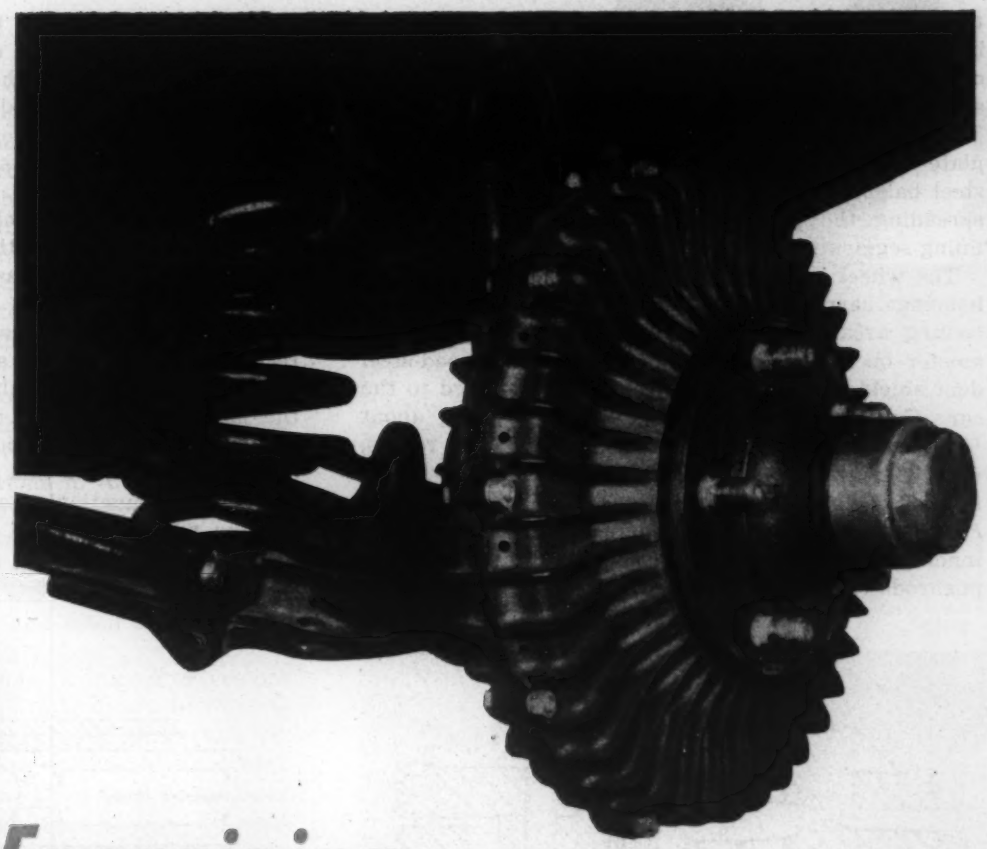


Fig. 1—External view of the new self-energizing disk brake showing the compact, neat design

Self-Energizing DISK BRAKE

. . . introduced by Chrysler is a major advance in automotive field

SINCE the introduction of the hydraulic automotive braking system some twenty-five years ago, the trend to heavier, faster cars has multiplied the braking effort required to stop a vehicle safely. With heavier cars moving at higher speeds, brakes obviously must be capable of absorbing much more heat energy, which in turn accentuates the problems of "fade" (decrease in coefficient of friction of the lining to increase in temperature) and "loss of reserve" (greater pedal travel required to obtain braking effect when the drum expands away from the lining due to increase in temperature).

Recent developments and progressive changes in conventional hydraulic brakes to meet these problems consisted mainly of: (1) The two-cylinder brake which provided greater fade resistance and more symmetrical lining wear; (2) the substitution of more rigid cast-iron drums for the original stamped steel type providing greater reserve and better wearing characteristics; and (3) the use of linings bonded to shoes with a special adhesive under heat and pressure, resulting in about 15 per cent more breaking area, longer brake life and reduced scoring of drums. However, the first real major advance in automotive brake design, now making its appearance on Chrysler Crown Imperial models, is the self-energizing disk brake, *Fig.* 1. Claimed advantages include more braking effect for the same size brake, less pedal pressure for the same amount of braking, more successive high-speed stops without noticeable increase in pedal pressure or reduction in braking effect, less pedal pressure when descending hills with continuous brake application, and automatic self adjustment throughout the life of the linings.

A brief description of the principle involved, design of the brake and the various components will show how these results are achieved. Basically, the self energizing disk brake utilizes two 12-inch cast-aluminum pressure plates in the form of annular rings inside a cast-iron brake housing. To obtain braking

the plates are moved apart along the axis of the housing until brake lining segments bonded to the outer surfaces of the plates contact the inside flat surfaces of the rotating housing. When the outer pressure plate is rotated with respect to the inner plate by movement of the cylinder push rods, *Fig.* 2, steel balls are forced up opposing "ramps", thereby spreading the plates to make contact between the lining segments and the housings, *Fig.* 3.

The wheel is bolted to the outer housing and both housings carry forty radial fins to provide maximum cooling area. The inner housing has a 9¼-inch diameter opening which is covered by a stamped-steel dust shield after the brake has been assembled to the car. Cast-aluminum pressure plates or rings, about ½-inch thick, have six equally spaced ball ramps, with 35-degree pressure angles, with a pocket at the foot of each ramp for a ⅞-inch diameter steel ball, *Fig.* 3. Two hydraulic cylinders are mounted on the inner pressure plate in such a way as to permit their pushrods to exert a combined rotational force against the outer pressure plate to start the braking action. To provide the desired ratio of braking effect between front and rear wheels, 1¼-inch cylinders are used on front brakes and 1-inch on the rear. A full lining is not used on the plates because it has been determined that an interrupted design has better cooling characteristics. Each segment is about 4 inches in length by ⅛-inch in thickness, and with two pressure plates acting, the brake has about 30 per cent more lining area than the conventional 12-inch shoe type brake.

Four slots in each pressure plate serve as locating recesses for the spider anchors, *Fig.* 4, the fit between the ends of the anchors and the slots preventing the plates from moving radially or off center. The malleable-iron spider is bolted to the steering knuckle on the front wheels and to the axle housing on the rear wheels, functioning as both a locater and anchor for the pressure plates. A spring-loaded plunger is located at the outer end of each of two adjacent an-

(*Continued on Page* 182)

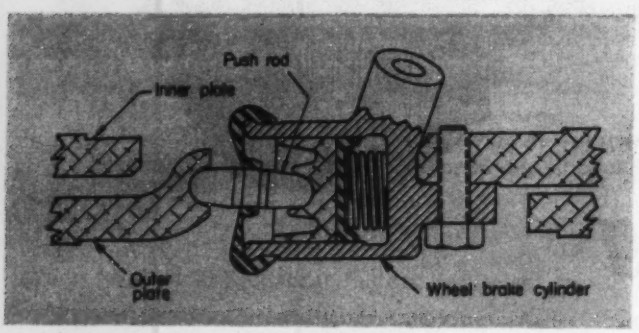


Fig. 2—Above—Cross section showing the hydraulic cylinder and pushrod assembly

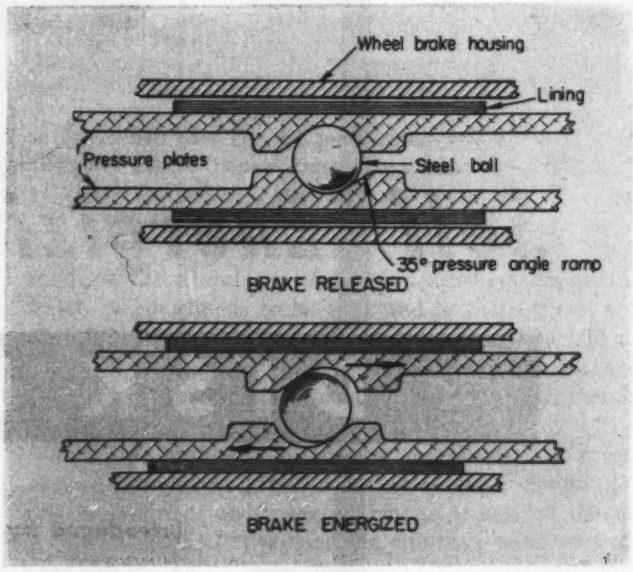
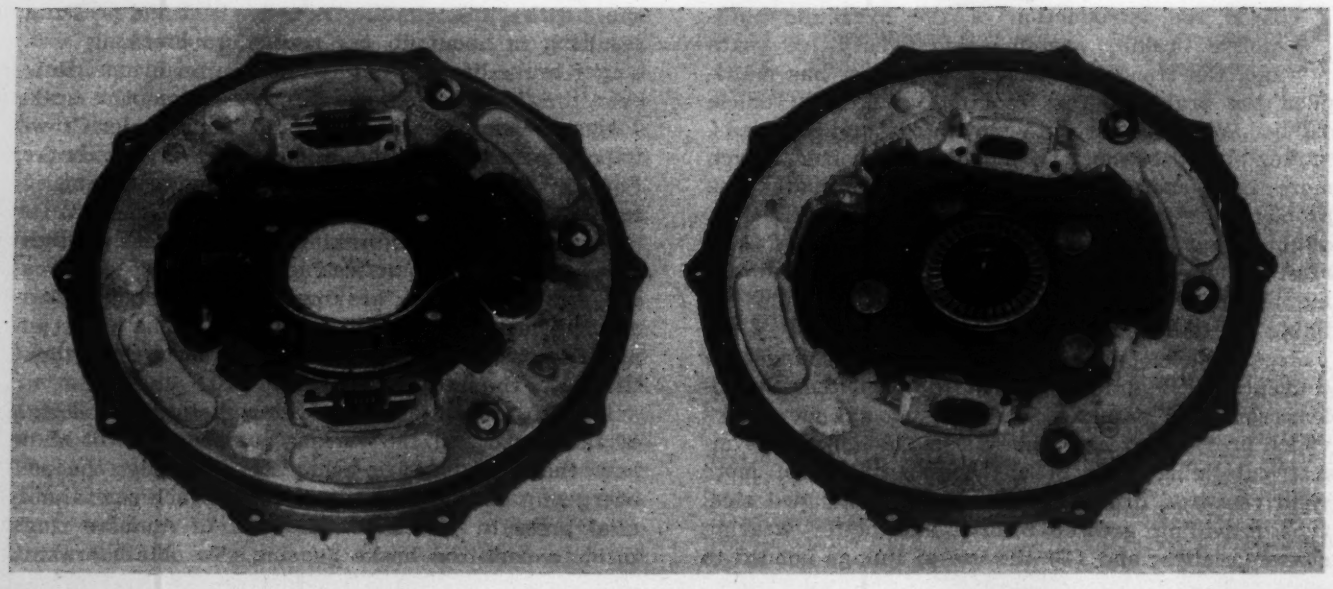


Fig. 3—Right—Cross section of brake showing balls and pockets which actuate the brake

Fig. 4—Below—View of both halves of the brake assembly with locating spider in place



ALUMINUM EXTRUSIONS

Design factors and tolerances

By H. V. Menking
Reynolds Metals Co.
Louisville, Ky.

ALUMINUM extrusions offer many possibilities that aid in the development of economical design and the reduction of fabrication costs. Engineers long accustomed to the use of rolled structural shapes and formed sheet sections are taking advantage of this important tool of engineering design.

Because extrusion dies are relatively inexpensive, special extruded sections such as illustrated in *Figs.* 1, 2 and 3 can be tailored to meet economically the needs of the design from the standpoints of utility, strength and stiffness. They can be designed to permit or facilitate joints with other members by adding flanges or ribs, or by changing section thickness. Metal may be placed where it will do the most good, and wall thicknesses of sections in aluminum extrusions may vary within broad limits. Several standard rolled sections often can be replaced by a single extrusion. Thus, overlapping metal sections are eliminated, the cost of joining is saved, and the resultant extruded member is simpler and often stronger than the built-up assembly.

Some typical examples of how aluminum extrusions replaced competitive materials are shown in *Figs.* 4, 5 and 6. *Fig.* 4 shows how a rolled shape was redesigned as a single aluminum extrusion. By adding ribs, lugs, pads, etc., extrusions can be tailored more economically than roll-formed sheet sections to meet specific design requirements and, by varying section thickness, they can often be made stiffer and stronger for equal weight.

Welded sections may be redesigned as one-piece aluminum extrusions, with resultant improvement in strength and dimensional accuracy, as illustrated in

Fig. 1—Extruded aluminum rolls used in textile machines are typical examples of design possibilities

Fig. 2—Below—Astradome for airplane nose employs a flange formed from an aluminum extrusion. Photo, courtesy Beech Aircraft Corp.

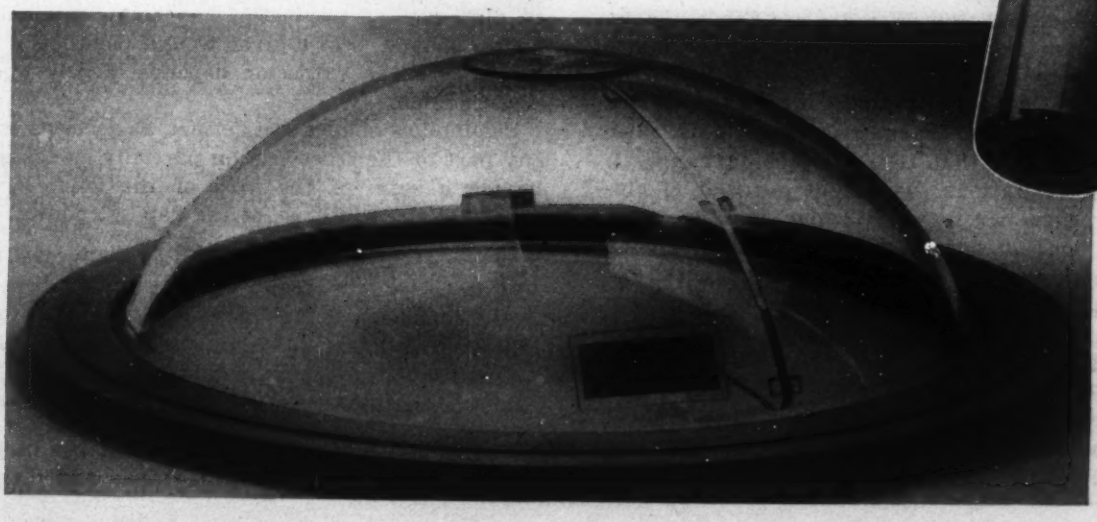


Fig. 3—Above—Extruded aluminum tail gate hinge

Fig. 5. Similar advantages are gained from redesign of brazed or crimped sections. Such extruded shapes, however, may require thicker walls than sections formed from sheet or tubing.

Extrusions cut to short lengths may be used to replace short castings, forgings or screw machine parts having uniform cross section in one direction. *Fig.* 6 illustrates a typical example.

MANUFACTURING LIMITATIONS: Limitations of extruded shapes with respect to size, weight and types of shape are as follows:

Maximum Cross-Sectional Area: Sections generally considered commercial are governed by a circumscribing circle approximately 12 inches in diameter. A limited number of 5500-ton presses available in this country can handle sections circumscribed by a 17-inch circle.

Section Thickness: Wall thickness of extrusions may vary from about .050-inch to several inches, depending on circumstances.

Ratio of Thickness to Width: The permissible thickness to width ratio of a section depends on the alloy used. The softer alloys can be extruded to thinner walls than can medium and high-strength alloys. For example, the minimum thickness for a shape about 8 inches wide is $\frac{3}{32}$-inch for 3S and 63S alloys but is $\frac{1}{8}$-inch for 14S alloy.

Minimum and Maximum Weights per Foot: Weight of an aluminum extrusion is governed by the limits of the extrusion ratio, which is the ratio of cross-sectional area of the cast extrusion ingot to the cross-sectional area of the extruded shape. This ratio should not be smaller than 16:1 nor greater than 45:1. Within these limitations the weight per foot of aluminum extrusions can normally range from an ounce or less to about 20 pounds, which corresponds to a cross-sectional area of over 15 square inches.

Maximum Length: Length of aluminum shapes is limited by heat treating and shipping facilities; it also depends on the weight per foot of the section. In general, 40 feet is considered the maximum length but lengths up to 80 feet can be furnished when heat treatment is not required.

TYPES OF EXTRUSIONS: Aluminum is extruded in the form of rod, bar, tubing, standard structural shapes and a wide variety of special shapes. Such special extrusions are classed, according to degree of difficulty of production, as solid, semihollow or hollow shapes. For a given weight per foot of length, the price of an extrusion depends largely upon this classification.

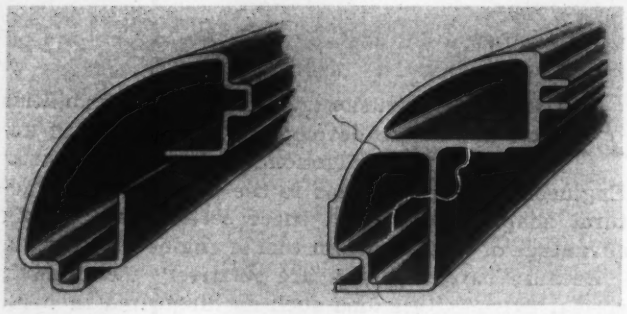


Fig. 4—Extrusion can be tailored to permit increased section thickness where required more readily than conventionally formed member at left

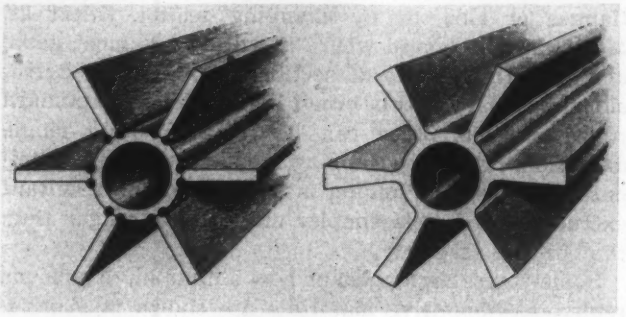


Fig. 5—Welded assembly may be redesigned for extrusion at right, reducing cost and increasing strength

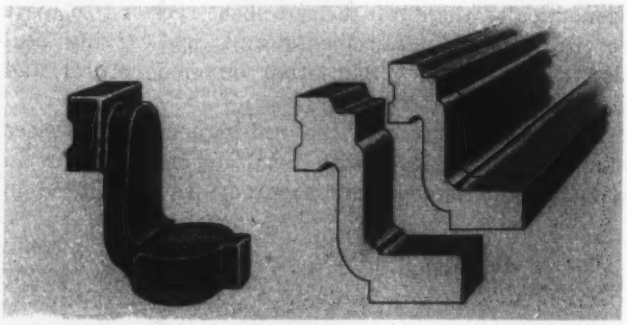


Fig. 6—Small forgings, castings or parts machined from bar stock, left, may permit redesign to an extruded shape, right, if cross section is symmetrical along one axis

Semihollow shapes are defined as sections in which any part of the cross-section partially encloses a void having a ratio of the area of the void, V, to the square of the width, w, of the gap as follows:

Gap Width (inch)	Ratio (V/w^2)
.030 to .062	Over 1½
.063 to .123	Over 2
.125 to .249	Over 3
.250 to .499	Over 4
.500 and greater	Over 6

In the case of higher ratios, the shapes may sometimes be extruded with the leg open and then closed

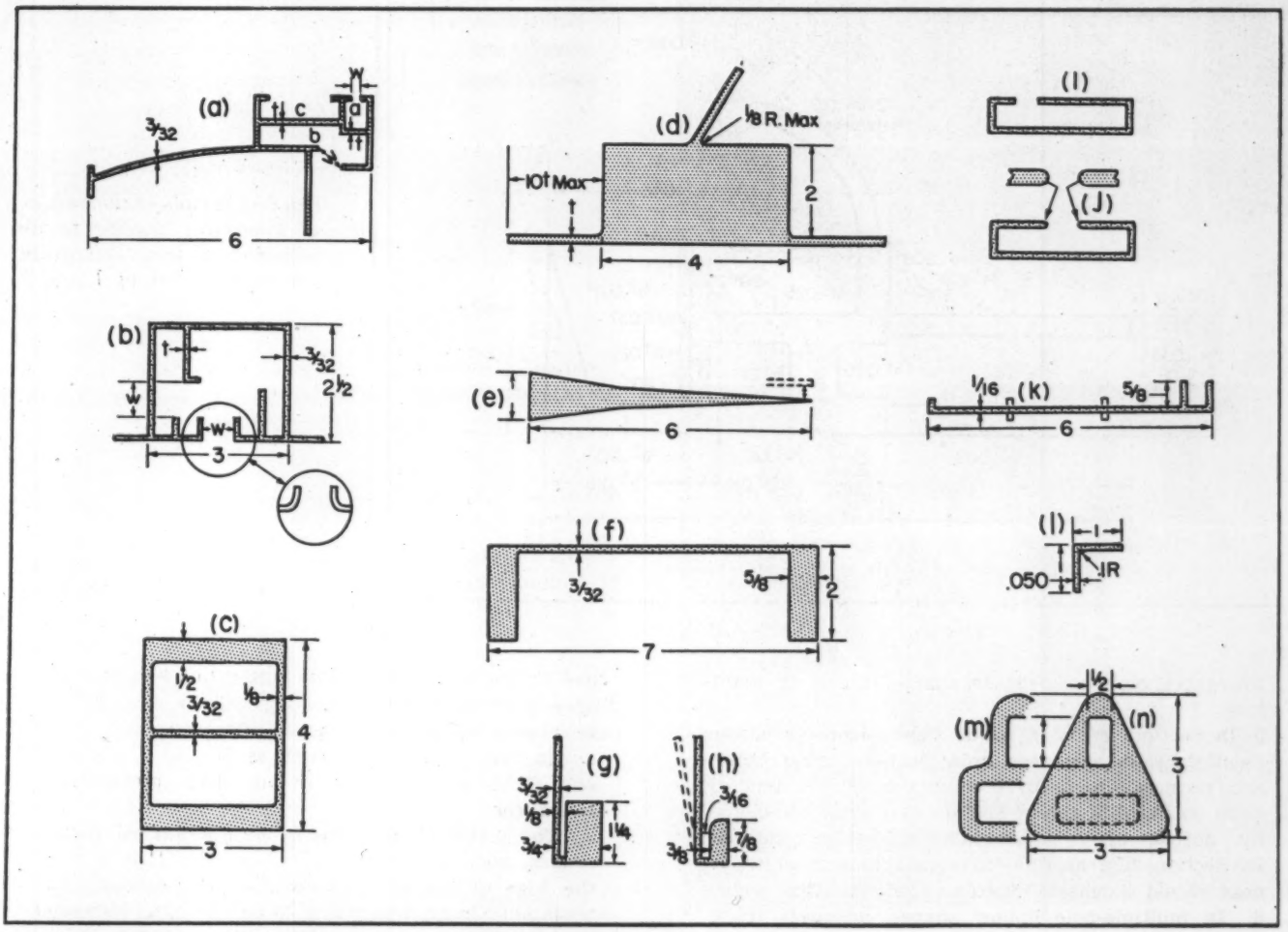


Fig. 7—Examples of extrusions which are difficult to produce. Conditions to be avoided include very thin sections with large circumscribing circle, semihollow sections with unbalanced tongues, extreme thickness variations, and hollow shapes with unsymmetrical voids or inadequate section thickness

in a subsequent rolling operation. When the tongue ratio is extremely high this method may no longer be applicable, and semihollow sections of this type may require being extruded in the same way as hollow sections.

Both semihollow and hollow shapes are more costly than simple solid shapes, but their advantages often outweigh the additional cost. In choosing between a hollow shape and a section built up from two or more simple extrusions, the designer should keep in mind that hollow shapes cannot be extruded as thin as solid sections, nor can they be extruded in the highest-strength alloys such as 24S, 14S and 75S.

On the other hand, assembly cost of hollow sections is much lower; there is no need to consider mating fits and tolerances of component sections. Moreover, the integral hollow shape is usually superior to the built up shape in strength and dimensional accuracy. A circumscribing circle of about 6 inches is generally accepted as the maximum for hollow shapes.

Special production equipment permits the extrusion of shapes in which the initial cross section is reduced to a smaller cross section at some point along the length. Such shapes are called *stepped extrusions* or *tapered extrusions*, depending on whether the change in cross section is abrupt or gradual. At present, they are limited to aircraft wing spars and similar applications.

DESIGN FROM MANUFACTURING STANDPOINT: Requirements of die design and other manufacturing considerations make it difficult to extrude certain types of sections, typical examples of which are shown in *Fig. 7*. These are as follows:

1. Thin-walled shapes with large circumscribing circles, such as Sections *a* and *k* in *Fig. 7*, are difficult to straighten. A slight increase in wall thickness, or stiffening ribs as indicated in *k* by dotted lines will remedy this condition

2. *Shapes requiring large overhanging die tongues, as illustrated in Sections *a*, *b*, *i*, and *j* of *Fig. 7*, create difficult problems in die design. The twisting action of the aluminum metal flowing by the die tongues, such as tongue *b* in Section *a*, may cause die breakage. Section *i* shows an unbalanced tongue; Section *j* the preferred, balanced tongue. The entrance to the tongue should be well rounded and, if possible, the width of the tongue gap (shown as *w* in Sections *a* and *b*) should be increased

3. In shapes with several adjacent die tongues such as *a*, *b* and *c* in Section *a*, an increase of section thickness, *t*, between the tongues, is desirable

4. Section *d* shows extreme differences of section thickness. To permit control of the metal flow, the length of the thin protruding legs should not exceed 10 times their thickness. Commercial dimensional

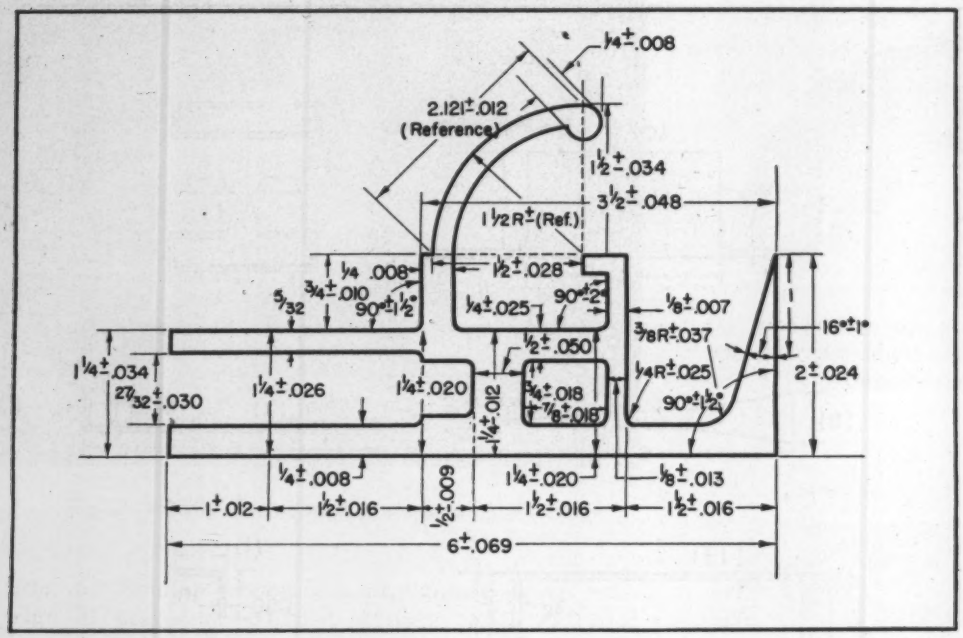


Fig. 8—Example of dimensional tolerances applied to an extruded shape. Tolerances are listed in Tables 1 and 2

tolerances on these thin legs are difficult to maintain

5. In Sections *e* and *f*, which show severe variations from thick to very thin cross sections, straightness and flatness are hard to maintain. Waves tend to form on the thin end of Section *e;* a blunt end shown by dotted lines would alleviate this condition. In Section *f*, a smaller difference in section thickness would facilitate flattening of the thin web

6. In multiple-hole hollow shapes, adequate thickness between holes is necessary. In Section *c*, for instance, the center web should be increased to ⅛-in.

7. Section *g* with a long narrow tongue flanked by a heavy mass of metal is extremely difficult to produce. The preferred design, which should be approached as closely as possible, is shown in Section *h*. Tongue width is increased, tongue depth reduced, the thick section is narrowed down, and a radius added at the tongue gap. The dotted line indicates the open position in which the leg will be extruded, to be closed by a rolling pass after extrusion

8. In very thin shapes, such as Section *l*, a generous fillet radius helps to maintain straightness tolerances

9. The metal flow of heavy unsymmetrical hollow shapes, such as Section *n*, where the void is near the edge of the section, is difficult to control. Extrudability is improved if a second void, as indicated in dotted lines, is added. The closer a hollow shape approaches uniform wall thickness, as illustrated by Sketch *m*, the more readily can it be extruded.

While most of the shapes illustrated in *Fig.* 7 may nominally fall within fabricating limits, they should, as far as feasible, be modified as suggested in the interest of greater economy and better service.

Table 1—Tolerances for Cross-Sectional Dimensions

Specified Dimension (inch)	Allowable Deviation from Specified Dimension[1]				
	Where 75 per cent or more of the dimension is metal[4] (inch)	Where less than 75 per cent of the dimension is Metal[2,3]			
		.250-.624 inch from base of leg (inch)	.625-1.249 inches from base of leg (inch)	1.250-2.499 inches from base of leg (inch)	2.500 inches or more from base of leg (inch)
Up thru .124	±.006	±.010	±.012	±.014	±.016
0.125– 0.249	±.007	±.012	±.014	±.016	±.020
0.250– 0.499	±.008	±.014	±.016	±.018	±.022
0.500– 0.749	±.009	±.016	±.018	±.020	±.026
0.750– 0.999	±.010	±.018	±.020	±.022	±.030
1.000– 1.499	±.012	±0.20	±.022	±.026	±.034
1.500– 1.999	±.016	±.024	±.028	±.034	±.050
2.000– 3.999	±.024	±.032	±.036	±.048	±.064
4.000– 5.999	±.034	±.042	±.050	±.064	±.088
6.000– 7.999	±.044	±.054	±.062	±.082	±.112
8.000– 9.999	±.054	±.064	±.074	±.100	±.136
10.000–11.999	±.064	±.074	±.088	±.116	±.160
12.000–13.999	±.074	±.084	±.100	±.134	±.184
14.000–14.999	±.080	±.090	±.106	±.142	±.196

[1] The tolerance applicable to a dimension composed of two or more component dimensions is the sum of the tolerances of the component dimensions if all of the component dimensions are indicated.
[2] At points less than ¼-inch from base of leg, the tolerances shown for 75 per cent metal are applicable.
[3] Where the space is completely enclosed (hollow shapes), the tolerances for 0.250 to 0.624-inch dimensions are applicable.
[4] When wall thickness completely encloses a space (hollow shape) 0.11 sq in. and over, tolerance is ± 10 per cent with max ±0.060, min ±0.010-in.

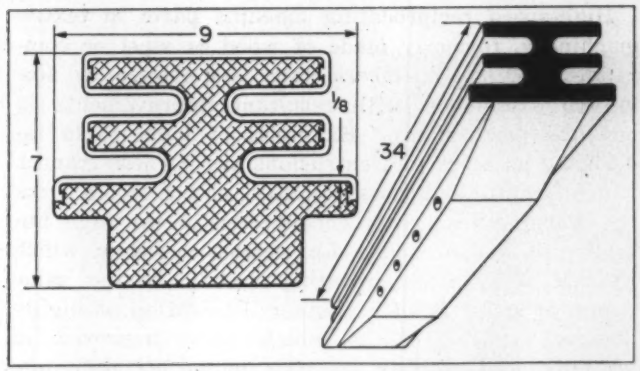


Fig. 9—Lightweight locomotive crosshead shoe, machined from an extruded aluminum shape, reduces unbalanced reciprocating weight

Large cross sections which are beyond maximum extrusion size, that is, which do not fall within a 12-inch circumscribing circle, can sometimes be extruded to a size near that desired and finished in a secondary roll-forming operation by flattening or bending.

DIMENSIONAL TOLERANCES: Although extruded aluminum shapes minimize and often eliminate the need for machining, they do not possess the dimensional accuracy of machined parts. The dimensional tolerances to which extrusions are commercially furnished therefore must be taken into account. These tolerances generally cover straightness, flatness, twist, and cross-sectional dimensions, such as section thickness, angles, contours, and corners and fillet radii. These are shown in TABLES 1 and 2.

Table 2—General Tolerances

Type of Tolerance	Dimensions to Which Tolerance Applies[1]	Tolerance
Straightness[2]	Circumscribing circle dia[3]:	
	up through 1.499-in.	±0.0500-in. per ft. for min thickness[4] up through 0.094
	up through 1.499-in.	±0.0125-in. per ft. for min thickness 0.095 and up
	1.500-in. and up	±0.0125-in. per ft.
Twist[2]	Circumscribing circle dia[3]:	
	up through 1.499-in.	±1° per ft.
	1.500-2.99-in.	±½° per ft; 5° total
	3.000-in. and up	±¼° per ft; 3° total
Contour	Deviation from specified	±0.005-in. per inch of chord width (±0.005-in. min.)[5]
Corner and Fillet Radii	Sharp corners	+1/32-in.
	Specified radius up through 0.197-in.	±1/32-in.
	Specified radius 0.188-in. and up	±10 per cent
Angles	Min. specified leg thickness	
	Under 0.188-in.	±2°
	0.188 to 0.750-in.	±1½°
	0.750-in. to solid	±1°
Flatness		±0.004-in. per inch of width (±.004-in. min.)
Surface Roughness[6]	Section thickness:	Max. depth of defect:
	up through 0.063-in.	0.0015-in.
	0.064–0.125-in.	0.002-in.
	0.126–0.188-in.	0.0025-in.
	0.189–0.250-in.	0.003-in.
	0.251-in. and up	0.004-in.

[1] These tolerances are applicable to the average shape. Wider tolerances may be required for some shapes, and closer tolerances may be possible for others.
[2] Not applicable to annealed (0 temper) material.
[3] The smallest circle that will completely enclose the shape.
[4] When weight of shape on flat surface minimizes deviation.
[5] Applicable to not more than 90° of any arc.
[6] Includes die marks, handling marks, polishing marks.

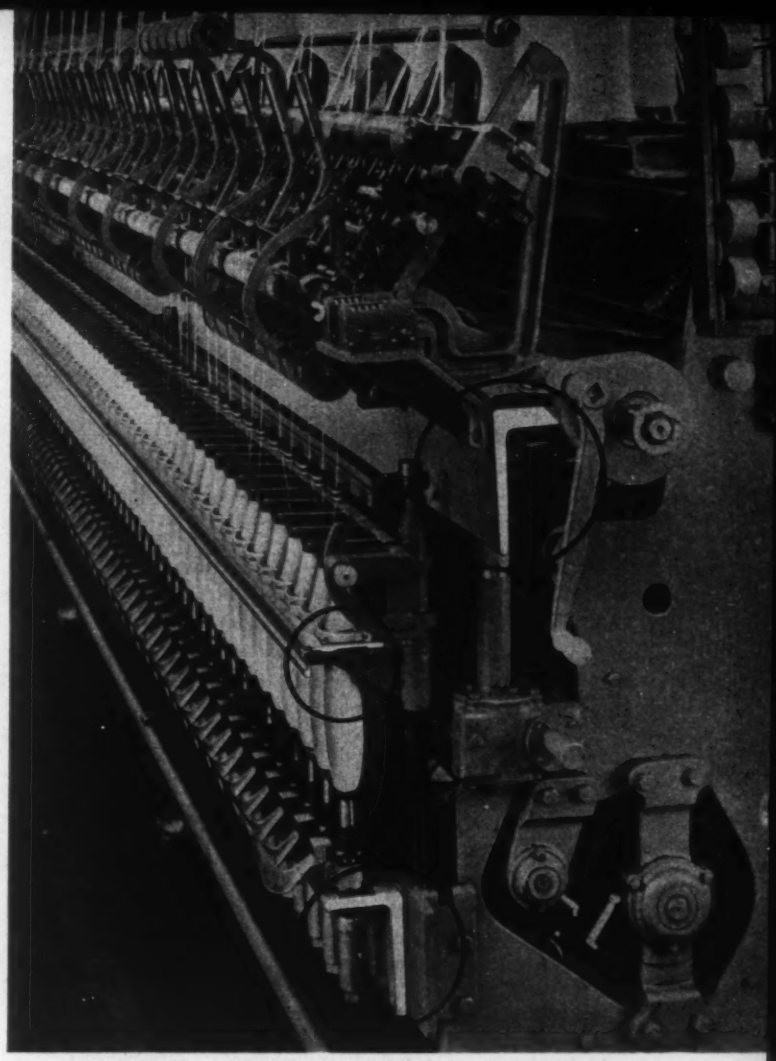


Fig. 10—Textile machine, built by McGlynn Hays, employs extruded aluminum members. Extruded parts are shown in circles at end of frame

Tolerances on any given dimension vary somewhat depending on the size and type of the shape, relative location of the dimension involved, and other factors. For instance, the 3 inch web of a 3 x 0.258-inch channel could vary from 2.976 to 3.024 inches, but when measured at the ends of the 1½-inch deep flanges the permissible variation on the 3-inch dimension could be 2.952 to 3.048 inches. Or, the tolerance on a ½-inch dimension may vary from 0.009 to 0.026-inch depending on the relative position of this dimension, TABLE 1. *Fig.* 8 illustrates many tolerances as applied to an arbitrary section used as an example.

Where highest possible precision is required in the assembled structure, it is wise to consider the various tolerances which will affect a given dimension. It should be kept in mind that some tolerances are cumulative.

If desired, it is often possible to furnish, at a moderate premium, extrusions with one-half of the com-

mercial tolerances listed in TABLES 1 and 2. Such better-than-commercial tolerances should be limited to the dimensions on which they are actually needed, as it is extremely difficult to hold all tolerances to half-of-commercial. If such special tolerances do not meet the designer's requirements, cross-sectional tolerances can sometimes be further reduced on relatively simple shapes by a cold-finishing pass. Otherwise it may often be more economical to specify extrusions with full or half commercial tolerances and to plan on a simple machining operation.

In dimensioning cross sections for extrusions, critical dimensions and tolerances should always be indicated, in order to facilitate inspection of the finished shapes.

FITS AND ASSEMBLIES: When extruded sections are assembled parallel with each other, each assembly must be handled as an individual case. Cross-sectional clearance pertaining to the fit or assembly must increase in proportion to the required assembly length. The following types of fits are employed:

Dovetail Fits are used primarily to form a single section from two or more extruded shapes. This is often done when the desired section is too large or complex to be extruded as a single shape

Contact or Contour Fits are the simplest to obtain, the principal requirement being that the contours of mating sections match as closely as possible

Snap Fits require sections designed with enough spring or deflection to permit assembly of the parts

Sliding Fits are frequently employed to form hollow shapes by sliding sections together. Aluminum is not recommended for sliding assemblies which are to be disengaged frequently because repeated friction between the parts generally results in galling.

APPLICATIONS: In aircraft design, aluminum extrusions, generally of 75S, 14S and 24S alloys, form the backbone of the wing and fuselage structure.

High-speed reciprocating machine parts in textile machinery, formerly made of wood or steel or composite wood-steel members, have been changed to aluminum extrusions, with resultant improvements in machine performance. Examples of loom parts redesigned as aluminum extrusions are harness frames, which require lightness, rigidity, and freedom from the warping frequently encountered in the high humidity of weave rooms. Lay beams in looms, which operate with a reciprocating motion in the same range of speed furnish another illustration of highly stressed wood sections which were improved in strength and rigidity by the change to aluminum extrusions; furthermore, distortion was eliminated and weight was reduced.

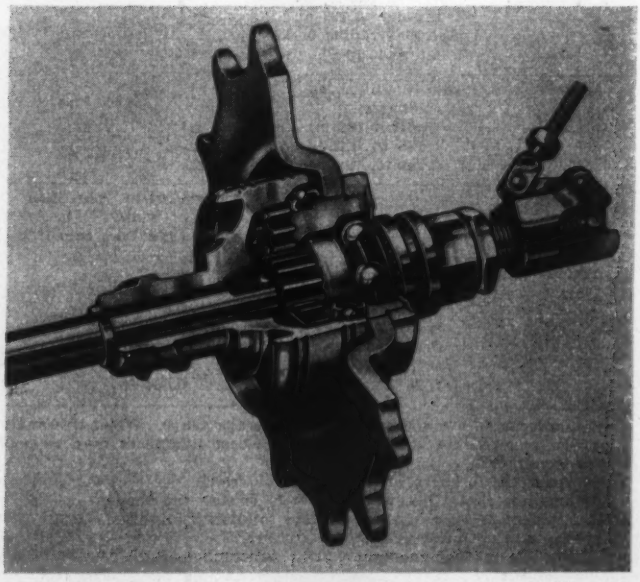
Locomotive crosshead shoes extruded from 70S alloy, such as the multiple type shoe shown in *Fig.* 9, have been adopted by several railroads, replacing other materials such as cast iron, cast steel, bronze, and aluminum forgings. Surfaces in contact with guides are lined with a ⅛-inch layer of tin. The aluminum shoes weigh 90 pounds each—a saving of 125 pounds per shoe or 250 pounds per engine. This weight reduction has greater advantage than its magnitude would indicate since it applies to unbalanced reciprocating weight. It permits lightening of the counterweights on the driving wheels by equivalent amounts and thus lessens vibration and destructive impact on the tracks.

Long frame members of uniform cross section can often be redesigned profitably as aluminum extrusions. Examples are found in spindle rails, roller beams and ring rails of cotton and wool spinning machinery, which range in assembled length up to about 50 feet. In such members, *Fig.* 10, the change to extrusions eliminated costly milling and planing operations as well as permitted the use of reduced cross sections of more efficient proportions.

Bicycle Pedaling Made Easier

PLANETARY gearing in a two-speed bicycle drive unit is used to give a low-gear direct-drive ratio and another gear ratio for high-speed, straightaway pedaling. When in direct drive, a sliding sun gear engages planetary pinions on the sprocket assembly and a mating internal gear on the driver or wheel hub assembly to lock the gear train. Shifting the sun gear to the right-hand position, as shown in the illustration, disengages sun gear and mating gear, causing the planet pinions to run around the sun gear and drive the wheel hub at increased speed. Gear shifting of the unit, manufactured by the New Departure Div. of General Motors Corp., can be accomplished while pedaling, braking or coasting.

Axial movement of the sun gear is accomplished through the hollow axle by a hand-operated toggle arm and pulley-and-cable arrangement. A variety of high and low gear ratios is available by using the desired combination of sprocket sizes.



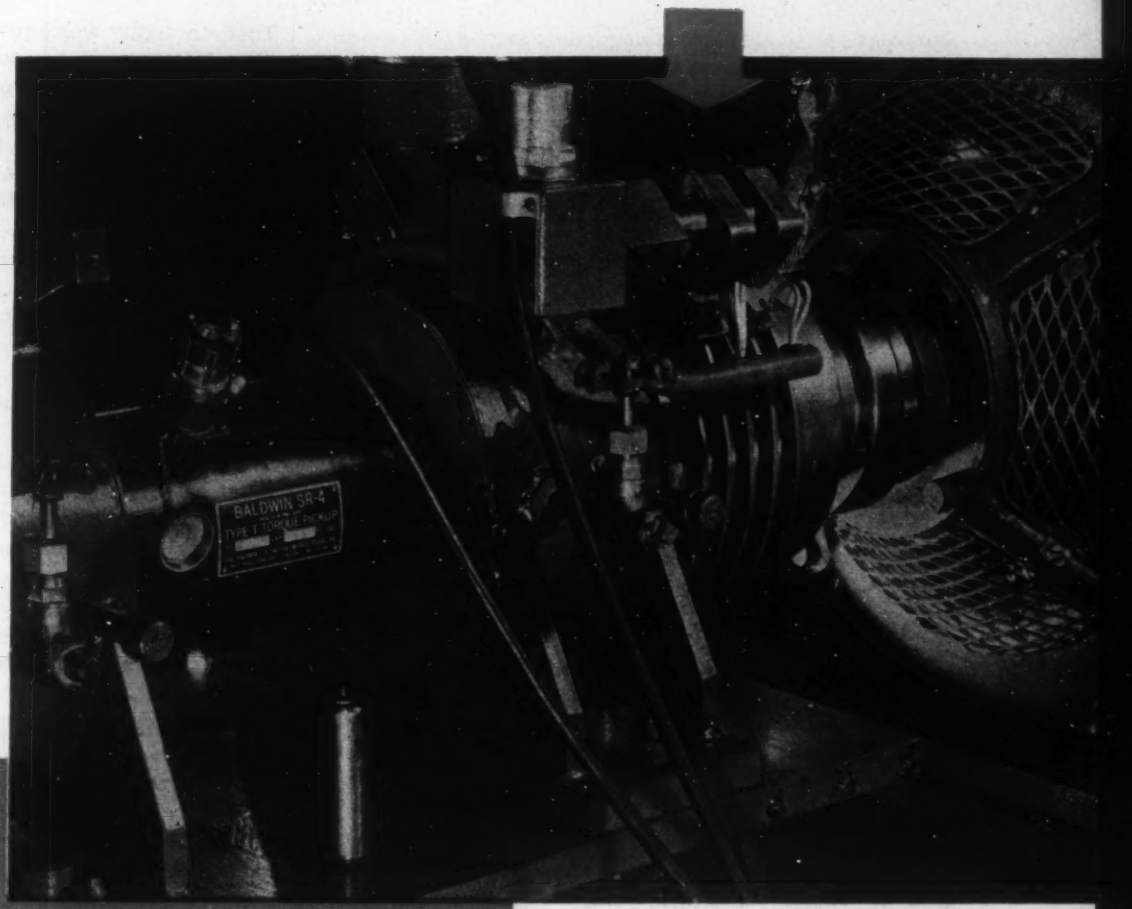


Fig. 1—Reluctance type generators, each producing the frequency range desired, are mounted on the driveshaft of pump-test stand

Electronic Tachometer

. . . provides accurate speed measurement

By Walter Richter
Engineering Development Div.
Allis-Chalmers Mfg. Co.
Milwaukee, Wis.

TO measure accurately the speed of centrifugal pumps for determining their performance characteristics, a novel electronic tachometer was developed to have an accuracy within 0.1 per cent of actual speed. This article will discuss the requirements of such a tachometer for pump testing, the various systems considered and the features of the unit illustrated in *Fig.* 1.

Four quantities—amount of liquid, head, torque, and speed—enter into the calculation of pump efficiency. Inaccuracies in any one will cause a percentage-wise equal inaccuracy in the figure of the efficiency. If any one of the four cannot be determined with an accuracy better than one-half of one per cent, for instance, the figure for the efficiency might be in error as much as two per cent, because the errors might all be in the same direction.

As far as speed is concerned, it was therefore necessary to investigate whether an accuracy within 0.1 per cent of a chart record of the speed could be attained without prohibitive complications and expense. The motors driving the pumps during a test run, which incidentally, takes only from a fraction of a minute to a few minutes, are squirrel-cage induction motors. With a 60-cycle system as the source of electric power, the possible speeds, confined to a range a few per cent below the synchronous speeds, are 3600, 1800, 1200, and 900 rpm.

With these limitations imposed on speed, it might well be asked why the whole problem of speed measurement could not have been conveniently solved by the use of synchronous motors as driving sources. Investigation of the frequency of the power system disclosed, however, instantaneous frequency variations

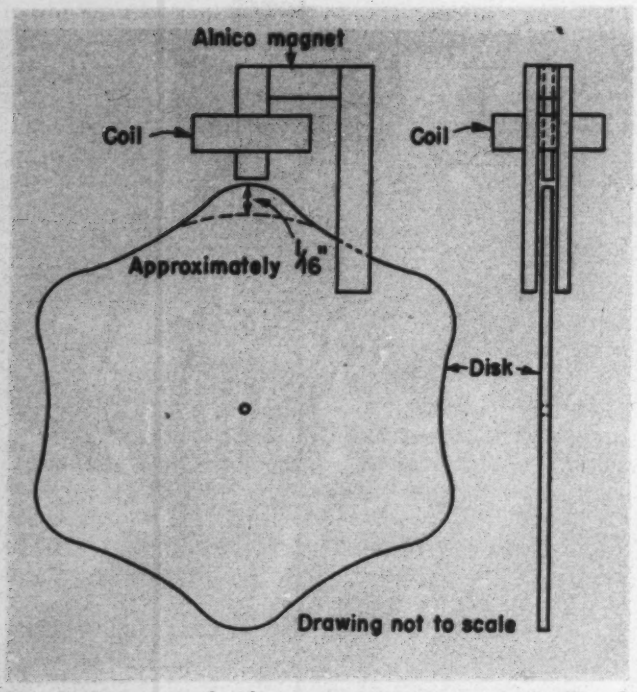


Fig. 2—Diagram of reluctance type generators in Fig. 1

of as much as 0.3 cycles per second, or ½ per cent, although over long periods of time such variations are, of course, averaged out. Consequently, the use of synchronous motors would still call for an accurate method of recording speed, but the increased cost of synchronous motors in the medium horsepower size field, as well as the more expensive control equipment needed for their operation made the induction motor the better choice.

Confinement of the speeds to be recorded to a few relatively narrow bands just below the synchronous speed of the motors made the solution of the problem somewhat easier. Whenever a quantity is to be measured accurately over a relatively narrow range, the logical solution is to obtain a reference quantity of accurately known value near the range to be covered, and then measure only the difference between the actual quantity and the reference quantity. For example, let it be required to measure a voltage varying between 100 and 110 volts; were this to be accomplished by the use of a direct-reading instrument with an accuracy of ½ per cent, this percentage would be the over-all accuracy of the measurement. But if an auxiliary source of voltage of 100 volts were available and known to be accurate to let us say 0.01 per cent (i.e., 0.01-volt in this case), the difference between actual voltage and this auxiliary voltage could be measured with a 10-volt instrument. If the accuracy of this instrument were again ½ per cent of full scale (i.e., 0.05-volt in this case) the overall accuracy would be approximately eight times as great as previously (0.06-volt compared to 0.5-volt).

This reasoning might lead immediately to a scheme whereby the motor speed would be converted into an electrical voltage. The difference between this voltage and a fixed auxiliary reference voltage would be used for the measurement and recording of speed. This thought was quickly abandoned, because no manufacturer of permanent magnet generators for tachometer purposes could guarantee the relation between generated voltage and speed to remain within 0.1 per cent over long periods of time. Aging of the magnets, thermal expansion of the field structure, and other factors would make such a guarantee impossible. To a lesser degree, obtaining a reference voltage and maintaining its value within 0.1 per cent or better would also present a problem, although the use of standard cells might conceivably be a solution.

Utilizes Frequency Measurement

If an a-c generator is used in place of a d-c generator, however, the frequency of the generated alternating voltage will remain absolutely invariable and accurate in relation to the speed of the generator. Furthermore, if electronic amplifiers are needed in the process of measurement and recording, deterioration or changes in the amplifier characteristics will not affect the output frequency. It is also a relatively easy matter to obtain a reference frequency with a very high degree of accuracy. Thus, it was decided to reduce the speed measurement to a frequency measurement.

The system, as finally developed, operates as follows: A number of reluctance-type generators are mounted on the drive shaft, the proper one being selected by the operator for any given motor speed. They are designed in such a way that each one, at the speed at which it is to be used, will produce a frequency of 180 cps if the driving motor selected for the particular test run were a synchronous motor running with a line frequency of exactly 60 cps. Owing to the slip of the induction motor actually used and to the instantaneous frequency variations of the line, the actual frequency furnished by the reluctance generator will be somewhere between 170 and 180 cps.

A temperature-compensated tuning-fork generator of the American Time Products Inc., furnishes a voltage with a reference frequency of 150 cps, with an accuracy of one part in 100,000. The frequency produced by the reluctance type generator is mixed with the reference frequency, and the best frequency, which will be between 20 and 30 cps is extracted and recorded on an Esterline-Angus frequency meter with a range from 20 to 30 cps. The accuracy of this instrument is given by the manufacturer as 2 per cent of the full 10 cps range, which in this case would be 0.2 cps. Essentially, therefore, the frequency of the reluctance type generator, which varies between 170 and 180 cps, is recorded with an accuracy of 0.2-cps (plus the negligible inaccuracy in the standard frequency) which is seen to quite satisfactorily approximate the desired accuracy of 0.1 per cent.

One of the reluctance type generators is shown in *Fig.* 2. It consists simply of a disk with the appropriate number of humps. As the disk rotates these humps pass before a pole piece with a coil wound on it, increasing and decreasing the air gap of a magnetic circuit containing a small Alnico magnet. With 6 humps, as shown in *Fig.* 2, 180 cps will be

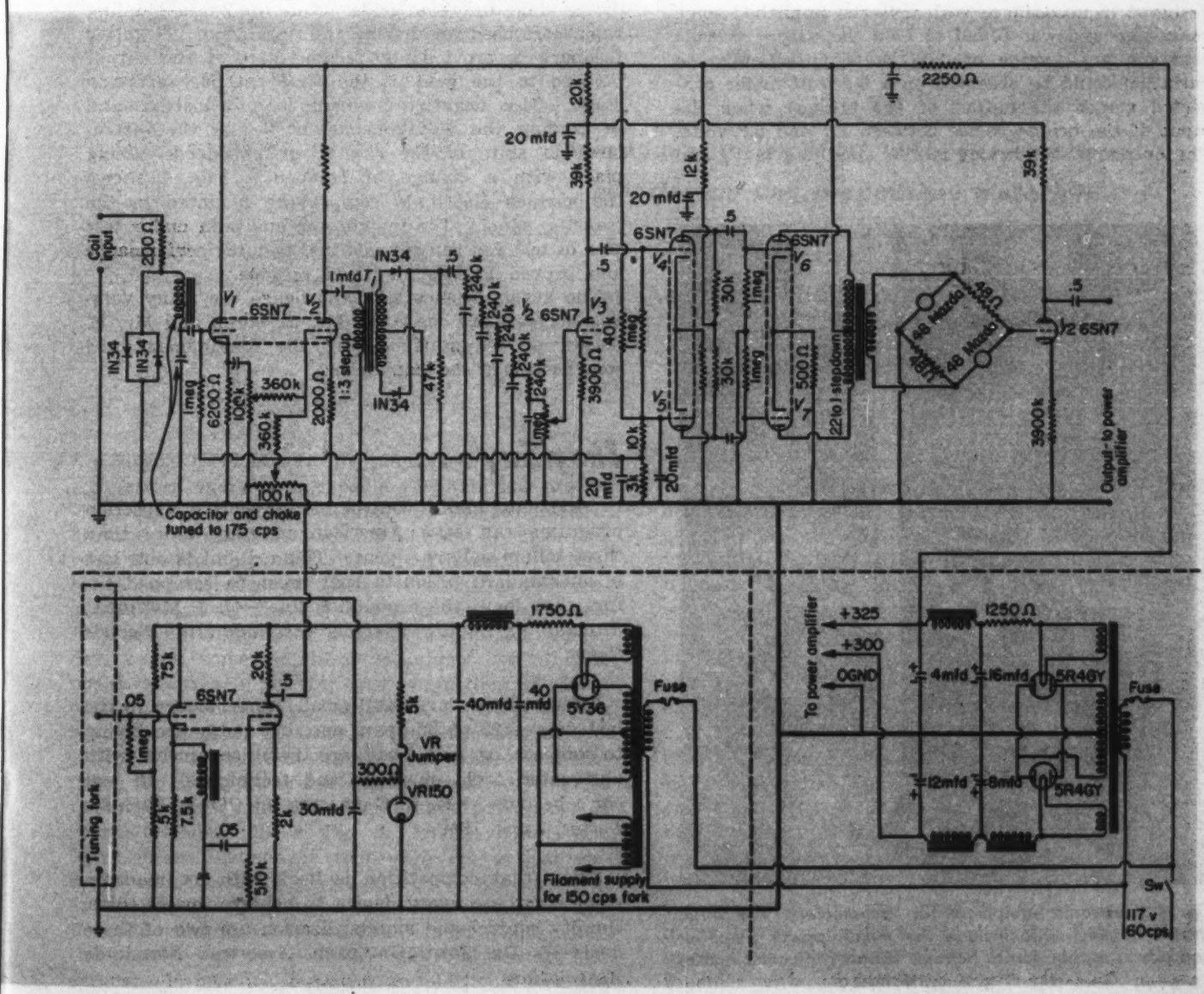
produced, when the disk is turning with a speed of 1800 rpm. *Fig.* 1 shows a number of different disks mounted on the test stand driveshaft.

Wave shape of the voltage induced in the coil of 1500 turns wound on the pole piece has deplorably little semblance to a sine wave. This could have been corrected, by doctoring up the contours of the humps by trial and error, but it was decided to accomplish this electrically for a few dollars in the manner described in the following discussion.

The output was filtered to approximately a sine wave before mixing it with the output of the fork. Output voltages of the several reluctance type generators used for the various ranges vary somewhat, making the use of some limiter scheme desirable. As seen in the diagram, *Fig.* 3, this is provided by a series combination of a 200-ohm resistor and two type 1N34 crystal diodes in a back-to-back connection. The voltage appearing across the two diodes is now limited, but still of poor wave shape. A fairly broad series resonant circuit tuned to 175 cycles is, therefore, placed across the two diodes, and the voltage appearing across the capacitor of this series resonant circuit is found to be of acceptable wave shape. This circuit cannot be loaded, however, without destroying its desired selective action, and the voltage is, therefore, fed to a positively biased cathode follower V_1 from the cathode of which the signal is fed to a 100,000-ohm potential divider.

Output of the 150 cps tuning fork, after having passed through a similar amplifying and smoothing circuit is also connected to a 100,000-ohm potential divider and the two arms of these potential dividers are connected to each other by a series combination of two 360,000-ohm resistors. The mixed signal appears at the junction point of these resistors. This signal, which consists of the sum of the 150 cps voltage and one whose frequencies varies between 170 and 180 is applied to the grid V_2 for further amplification. The center-tapped output transformer T_1 in the plate circuit of this tube permits full wave rectification by means of the two diodes, type 1N34. A simple five stage RC filter network sufficiently rids the output of the rectifier of the 150 and 170 to 180 cps ripple, leaving a fairly pure sine wave of

Fig. 3—Circuit diagram for electronic tachometer



the beat frequency across the output potential divider of the filter network. The d-c component is blocked out by the 0.5-mfd capacitor between the 47,000-ohm load of the rectifier and the filter.

The signal with the beat frequency is now amplified in V_3, converted into a push-pull signal by means of cathode inversion in tubes V_4 and V_5, and further amplified in the tubes V_6 and V_7. This part of the circuit is fairly standard, but attention is called to the large values of coupling capacitors and grid resistors, dictated by the low frequency to be amplified.

Employed for eliminating the 150 and the 170 to 180 cps voltages, the ripple-filter network cannot help but affect the beat frequency which it is desired to pass. Since the beat frequency varies between 20 and 30 cps, the output voltage of the filter network, applied to the grid of V_3, changes over a wider range than deemed permissible for the operation of the final load. Some kind of automatic volume control, therefore, seemed to be indicated. This is accomplished in a simple and satisfactory manner by the bridge circuit on the output side of the V_6-V_7 output stage, consisting of two No. 48 Mazda pilot lamps and two 48-ohm resistors. This bridge was designed in accordance with material published some years ago and was found to hold the output voltage constant at a value of 1.17 volts (practically no variation could be observed on a 0-5 volt meter connected across the output of the bridge) when the input of the bridge varies between 1.7 and 5.2 volts. The output of the bridge is now amplified in V_8 and is then ready for application to the power amplifier.

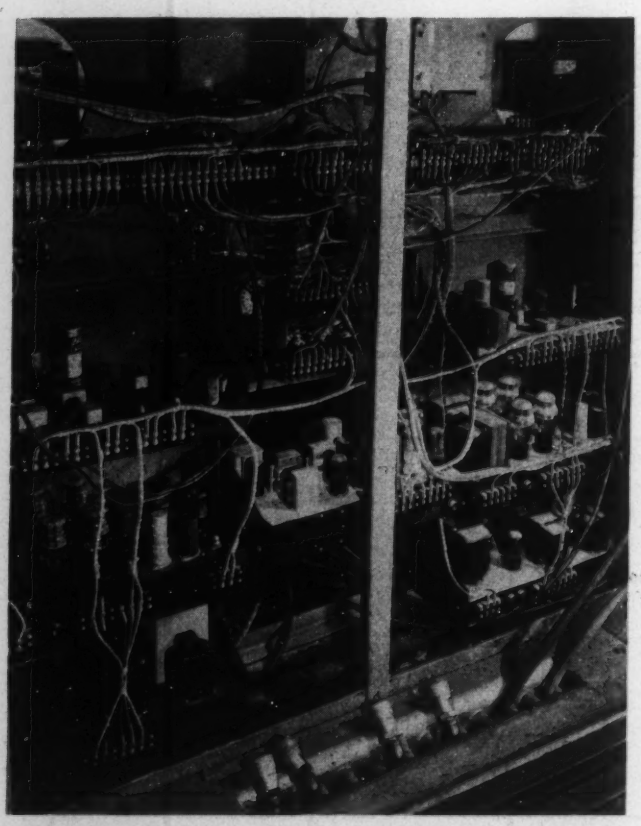


Fig. 4—Electronic equipment for tachometer. The three chassis on each side include the mixer, power amplifier and power supply, top to bottom. Chassis in center houses the frequency standard

Power consumption of the frequency meter used was found to be between 12.5 and 17 volt-amperes, in the range of 20 to 30 cycles, varying with the frequency. The voltage across the instrument can deviate considerably from the rated value of 115 volts without affecting the indication of the instrument, although response is slower at lower voltages. The wave shape of the voltage applied to the frequency meter may also deviate from a sine wave. Nevertheless it was deemed desirable to strive for a good wave shape. Any good power amplifier capable of furnishing approximately 15 watts at 115 volts, at a frequency between 20 and 30 cycles, may therefore be inserted between the circuit shown in *Fig.* 3 and the frequency meter. The amplifier used employs four 2A3 tubes with a negative feedback and was found entirely satisfactory for the purpose.

Owing to the low frequency at which good response is still demanded, a special output transformer had to be constructed but, apart from this feature, the amplifier is reasonably standard. It might be pointed out that the low values of grid resistors required for fixed bias operation of the 2A3 tubes made it necessary to employ a push-pull cathode follower as a driver stage for these grids. Note the 2-mfd coupling capacitors used for driving the final stage. Negative feedback is provided by feeding part of the output voltage to the grid of the first cathode inversion stage. This negative feedback loop is instrumental in holding the voltage constant across the instrument in spite of the change of impedence taking place with a change of frequency. *Fig.* 4 shows the various electronic components mounted in the transfer panel. The instrument has been under test and in use for several months, and its performance has proved satisfactory and reliable.

The author wishes to acknowledge the many valuable suggestions made by Mr. J. Borek and Mr. E. Seiser, of his staff, during the development and construction of the instrument.

They Say . . .

"Adequate quality control and preventive inspection programs can save American industry more than three billion dollars a year. This amount is now lost in substandard products that must be scrapped before they leave the production line"—J. J. MANUELE, *director of quality control, Westinghouse Electric Corp.*

"Many shops, large and small, were modern to the last degree 25 or 30 years ago, but today are trying to compete, or, may I say, are trying to survive, with antiquated tools, methods and techniques. It just can't be done"—E. B. GALLAHER, *in Clover Business Letter, April,* 1949.

"Now that competition is back with us, management must use every device to achieve lowest costs. Quality control and standardization are two of these devices"—DR. JOHN GAILLARD, *American Standards Association.*

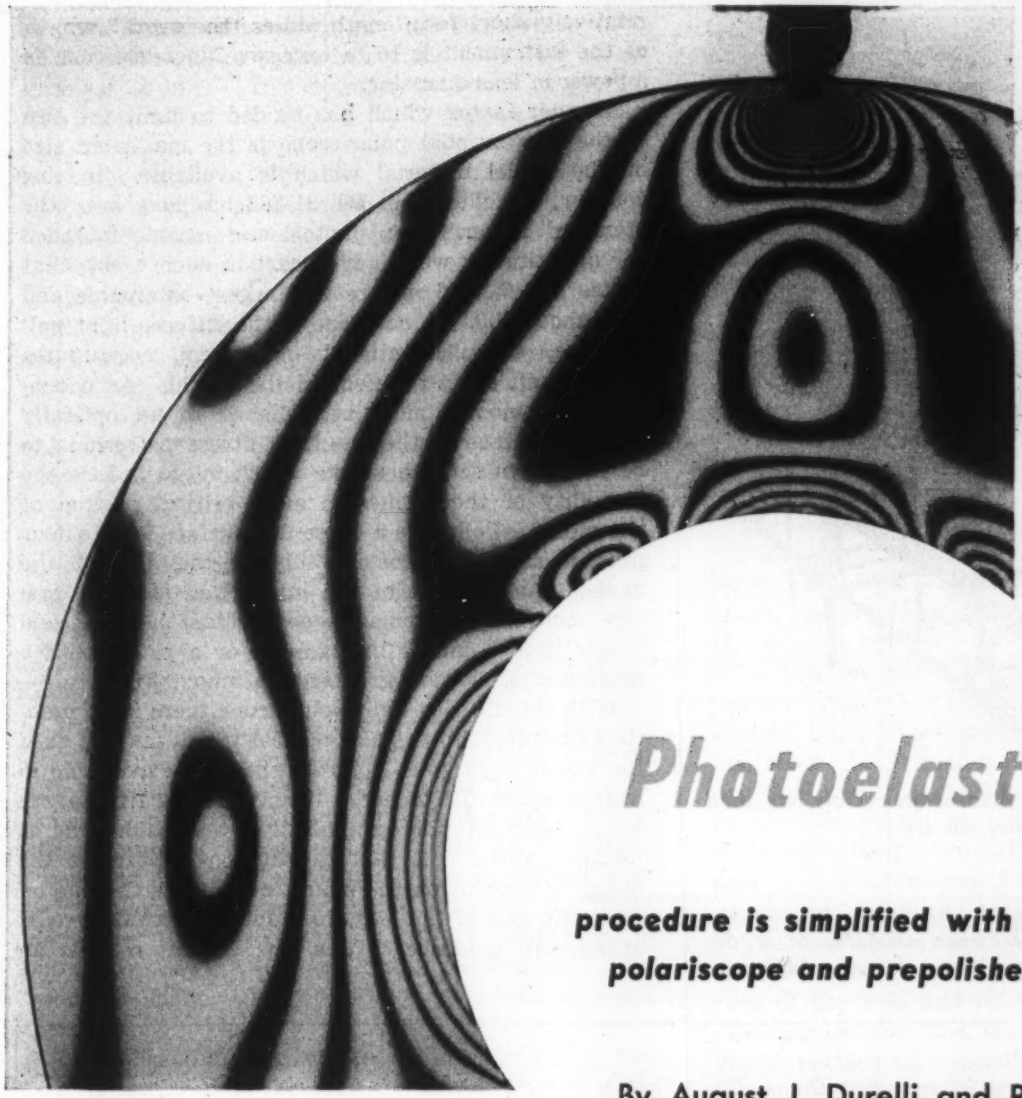


Fig. 1 — Portion of a light-field stress pattern of a ring under diametral compression showing width of boundary shadow obtained on diffused-light polariscope. Outside diameter of the model is 2.75 inches

Photoelasticity

procedure is simplified with diffused-light polariscope and prepolished materials

By August J. Durelli and Rex L. Lake

Research Engineers
Armour Research Foundation
Chicago, Ill.

THEORETICALLY, the photoelastic method of stress analysis is capable of producing precise results by simple means, *Fig.* 1. In practice, however, the attainment of this inherent precision has been possible only with the aid of a costly optical setup and the use of extremely complicated techniques, requiring manual skill of a very high order. This article will discuss a diffused-light polariscope, *Fig.* 2 and some simplified techniques which it is hoped will make possible the production of stress patterns of reasonably good quality by those who do not have the skill required by conventional methods.

DIFFUSED-LIGHT POLARISCOPE: A comparison between the two types of conventional polariscopes most commonly used and the diffused-light polariscope is shown schematically in *Fig.* 3. In the case of the Nicol prism instrument there are six optical elements which must be placed exactly in line and then adjusted to the proper position along that line. The Polaroid polariscope is somewhat more simple since the positions of the polarizer and analyzer are not critical. In practice, however, an additional lens (or lenses) is usually introduced between the second field lens and the camera to make it possible to vary the size of the stress pattern without having to move the camera. In contrast, the diffused-light polariscope uses only one lens and the only adjustment required is that of focusing. In industrial laboratories, where several persons may use the same instrument or where shortage of space requires the photoelastic laboratory to be shared with other activities, the ease of adjustment of the diffused-light polariscope becomes a factor of considerable importance.

Necessity of using field lenses has limited the size of the conventional polariscope field. Even though the use of monochromatic light makes it possible to employ single-element lenses, they must be of the best quality to minimize the effects of spherical abberation and curvature of the field. In the Nicol prism instrument, the field lenses are in the path of the polarized light and must be chosen carefully in order that they do not add to the stress pattern their own pattern of residual stress. These considerations, together with the fact that field lenses must have a

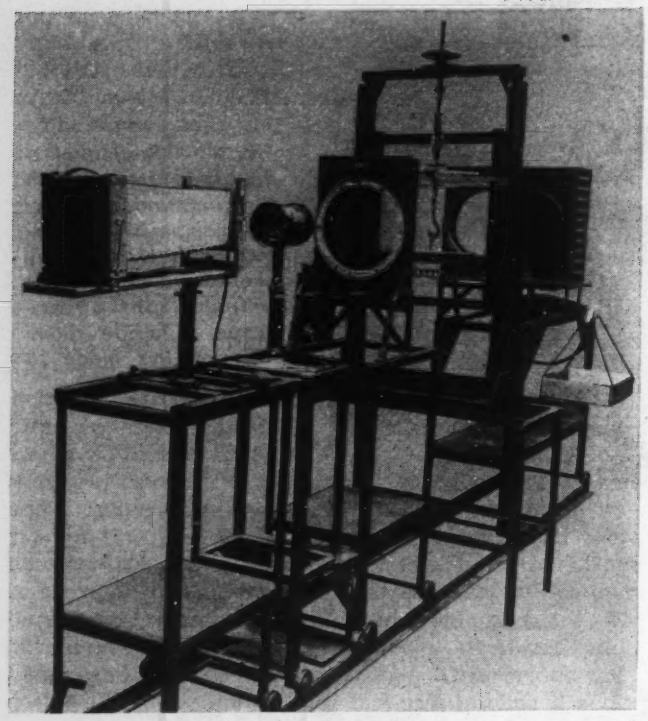


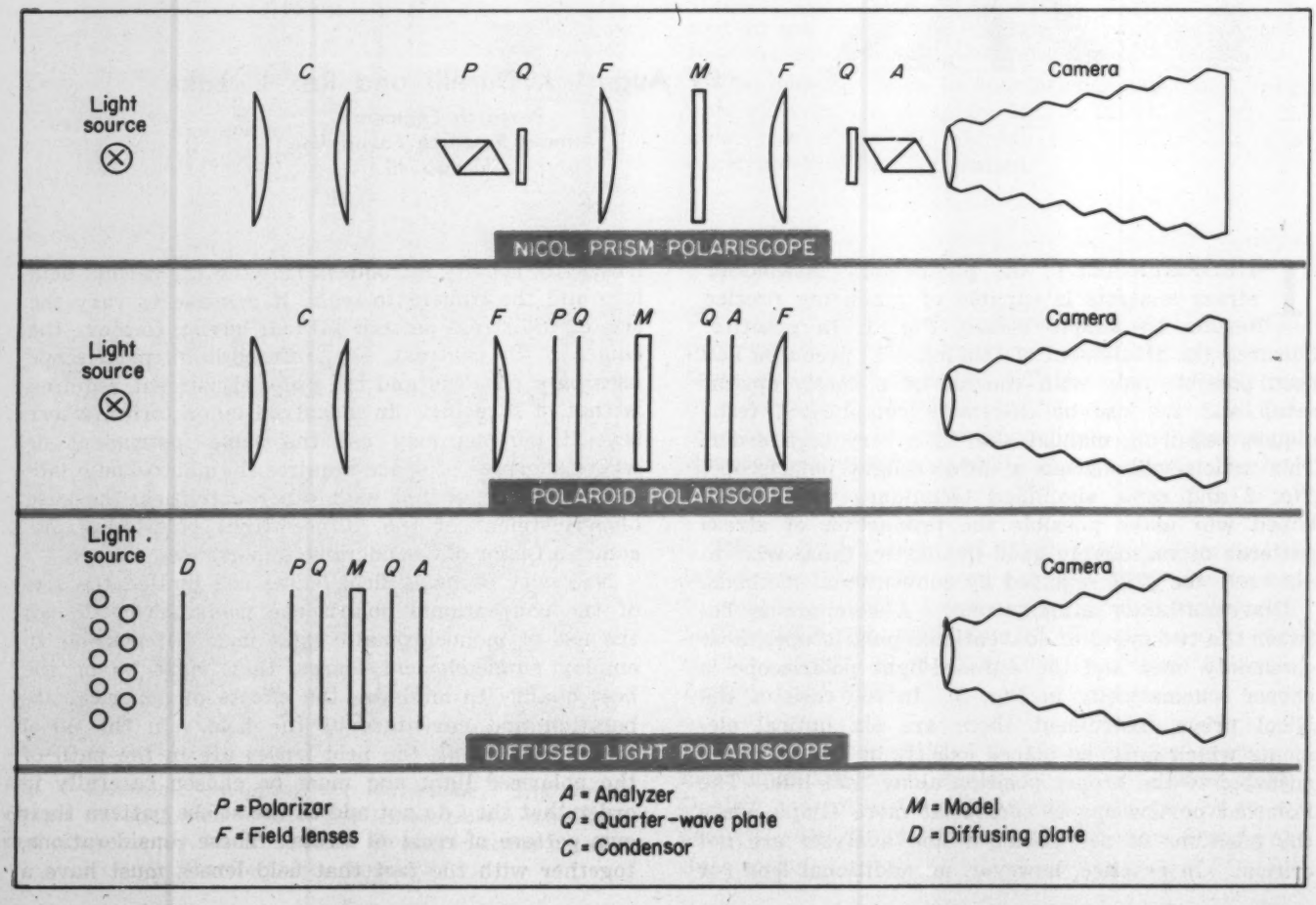
Fig. 2—Above—Diffused-light polariscope. Only lens used is that of the camera

relatively short focal length unless the overall length of the instrument is to be excessive, increase cost as a power of lens diameter.

Another factor which has tended to limit the size of the conventional polariscope is the maximum size of the model material which is available. In this country, Bakelite resin BT 61-893 has long been the standard material for photoelastic models intended for quantitative work. It is cast in such a size that plates 1 x 6 x 12 in. are the largest obtainable and cost about $60. In contrast to the diffused-light polariscope, the conventional instrument accentuates every small surface defect of the model. As a consequence, models must be polished to an optically smooth surface if the resulting stress pattern is to be free from scratch marks which might reduce the visability of the fringes in some critical portion of the model. Polishing a large flat surface is a tedious process and adds considerably to the cost of the model. As a result of the interaction of these factors, conventional polariscopes seldom have a field larger than 6 inches in diameter or a model with a maximum dimension greater than about 5 inches.

With the diffused-light polariscope there is no practical limitation to the size of field which may be used for visual work since polaroid sheets are available in widths up to 70 inches. When stress patterns are to be recorded photographically, the usable field is limited by the fact that the light which forms the image of a point on the model, other than the one on the optic axis of the lens, does not traverse the model at normal incidence. Thus, the camera records an

Fig. 3—Below—Comparison between elements of a diffused-light polariscope and two conventional polariscopes



average which, conceivably, may not be representative of the true state of stress in regions where the stress gradient is high. The situation is shown in greatly exaggerated form in *Fig.* 4. The camera sees only the stresses in the shaded cone while the outer area is photographed as a shadow.

Width of this shadow depends, in an obvious way, on the thickness of the model and the angle subtended at the lens by the distance, *r*, of the boundary in question from the optic axis of the system. This angle is primarily dependent on the model-lens distance which is, in turn, a function of the focal length of the lens and the magnification between model and stress pattern. It may be shown, theoretically, that the width of the boundary shadow produced by a model 0.25-inch thick will be about 0.014-inch (measured on the model) at the edge of a 12-inch field when a lens of 30-inch focal length is used at a distance of 105 inches. Under these conditions, the edges of the field are contained within the long dimension of a 4 x 5-inch film.

Boundary Shadow Is Unobjectionable

As the lens is moved nearer to the model, the size of the field which can be photographed on a given size film will be reduced. In practice this width of boundary shadow will not be exceeded on a 4 x 5 film at any model-lens distance down to 42 inches. Thus, one of the principal objections to the diffused-light polariscope, namely that it does not faithfully reproduce the stress pattern near a boundary, is shown to be of little practical importance. The boundary shadow shown in *Fig.* 4, for example, is not excessive.

The diffused-light polariscope shown in *Fig.* 2 has four separate units mounted on rails in such a manner that they may be moved easily with respect to each other. In the background is seen the lamp house and the polarizer, together with its quarter-wave plate, mounted on a single unit. Next, there is the strain frame, which rests on the floor, then the analyzer unit, the lens and, finally, the film holder. The last two units comprise the camera. Since this picture was taken, it has been found desirable to mount the shutter on the lens rather than on the front of the view camera, which serves as the film carrier, in order to prevent the camera from acting as a field stop at the higher magnifications.

The light source consists of a bank of thirteen 15-watt "green" fluorescent lamps. These lamps are arranged in two staggered banks in such a way that no visable gaps are present. A piece of flashed opal glass provides the additional diffusion necessary to produce a uniform field. Although the light produced by these lamps appears almost white to the eye, it is almost completely lacking in those wave lengths below 4800 and above 6000 Angstrom units. Used visually, this source is sufficiently close to white light to permit the easy identification of points of zero fringe order which will appear as a blue gray, while the remainder of the field will be either a bright blue or a yellow green. When stress patterns are to be photographed, a Wratten 77 filter is employed at the camera lens position.

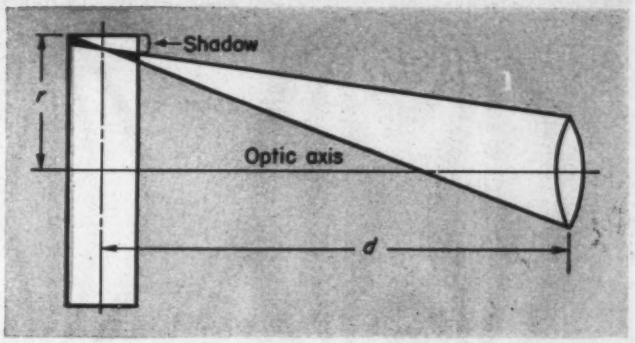


Fig. 4—Exaggerated representation of the effect of lack of parallelism in the beam of light

The combination of light source and filter produces a wave length band about six hundred Angstrom units wide which would seem to be a considerable departure from the ideal of monochromatic light. However, it has been found possible to take pictures of a disk under diametral compression in which 32 fringes could be counted. Since even this figure is beyond the proportional limit between fringe order and stress, the source would seem to be adequate for practical work. A more nearly monochromatic source could undoubtedly be obtained by the use of mercury-vapor lamps and suitable filters but only at the cost of a less uniform field, considerably more heat generation and initial outlay for equipment.

The lens shown in *Fig.* 2 is an inexpensive Rapid Rectilinear type. It is not fully corrected for curvature of the field and is, therefore, not the best possible choice for this type of work. To produce a stress pattern of adequate size while maintaining a reasonably long model-lens distance, the focal length of the lens should be at least twice the field diameter. The lens need not be a fast one, since it will be limited to an actual aperture of 2 inches by the filter.

In the matter of film, the authors have found a fast orthochromatic emulsion to be the most suitable for all around work. The developer should be chosen for the best possible compromise between high contrast and fine grain. The formulas given in most handbooks for use in photomicrography are suggested.

PREPOLISHED MATERIALS: As indicated previously, the production of a satisfactory photoelastic model from Bakelite BT 61-893 resin is a process requiring much time and skill. The reader is referred to Frocht's *Photoelasticity*[1] for a discussion of this subject. One possible way around this difficulty lies in the use of Catalin or BT 48-306: These materials have been used for some time for qualitative work and for student instruction, but have been frowned upon for quantitative work because of their tendency to creep under load. Both materials are obtainable in the form of sheets "cast in glass", which means that their surfaces are as smooth as the plate glass against which they were cast. The model is produced by the simple procedure of trimming it to the required outline. This is best accomplished by the use of a lathe,

[1] References are listed at end of article.

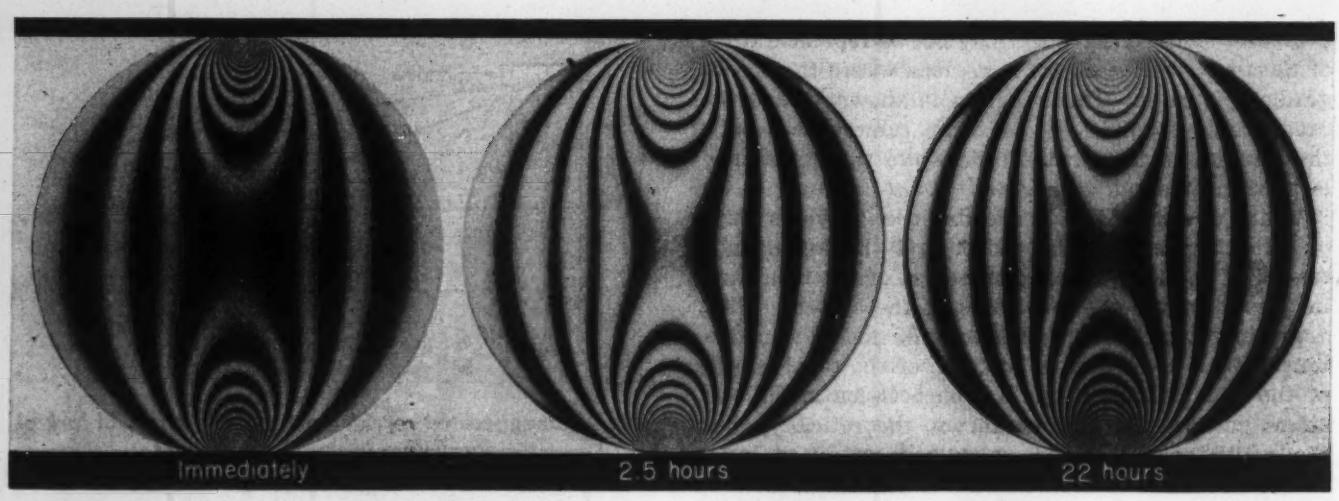


Fig. 5—Effect of time on creep in Catalin under constant load immediately, after 2.5 hr and after 22 hr

high speed milling cutters or hand filing to a metal template as the geometry of the model indicates.

These prepolished materials frequently show a considerable amount of residual stress which may be removed by a suitable annealing cycle. The authors use a large oil bath at 165 F for this purpose. The material, carefully supported to prevent warping, is held at temperature for times ranging from eight hours to three or four days and then allowed to cool in the bath. In practice, the shorter times have given good results.

In working with BT 61-893, it is customary to determine a material fringe value which is usually defined as the stress required to produce one fringe in a model 1-inch thick. In the case of BT 61-893, the fringe value has been found to be so nearly constant from lot to lot of the material that it need be checked only when precise results are wanted. Such a method of working is not possible if the model material creeps under load, for then the fringe value becomes a function of time.

If a model is subjected to a constant deformation, a stress pattern will be produced. Both the fringe order and the force required to hold the model in the deformed position will gradually diminish with time until after a very long (theoretically infinite) period the fringe order will have been reduced to zero and the deformed shape will be the equilibrium shape of the model. The physical explanation of these phenomena is to be found in the field of high polymer theory[2] and is beyond the scope of this article.

In order to investigate this behavior, the authors used a disk under diametral compression. A number of stress patterns were obtained at times from thirty seconds to twenty-two hours after loading. Catalin and BT 48-306 were tested under both constant load and constant deformation. A series of graphs was then constructed showing the shear stress as a function of position for the diameter of the disk, which was perpendicular to the line of the loads. Typical examples are shown in *Figs.* 5 and 6.

For purposes of comparison, the curves in *Fig.* 6 were "normalized" by multiplying each ordinate by the factor necessary to make the central ordinate equal to ten. The agreement of these curves among themselves and with the theoretical solution was such as to indicate that the fringe values of these materials is a function of time only. In other words, the stress pattern produced by a model which has been creeping under load for as long as twenty-two hours is still exactly similar to the one which appears immediately upon application of the load in the sense that both patterns agree with the solution given by the theory of elasticity.

Accordingly, it would seem to be necessary to know the entire creep curve of the material and to know exactly the time after loading at which any given stress pattern was obtained, if quantitative work is to be done. Fortunately, such is not the case. In practically every model, there is a zone in which the stress distribution is essentially uniform and such that its magnitude may be computed by the usual formulas of the theory of elasticity or strength of materials. For example, the shanks of the hook in *Fig.* 7 are in a state of nearly uniform tension. All fringe orders may then be compared with that existing in this uniform zone. The model thus becomes autocalibrating.

In those cases where such a uniform zone does not exist, it is often possible to introduce one without altering conditions too radically. Otherwise, the load may be applied to the model through a calibration specimen which has been machined from a portion

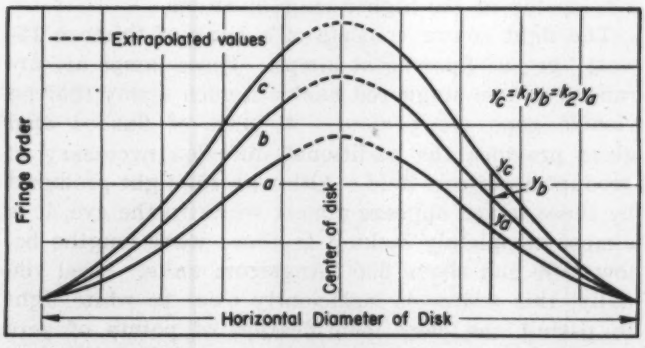


Fig. 6—Creep in Catalin under constant load. The fringe value (optical sensitivity) changes but is only a function of time. The photoelastic pattern shown in Fig. 5 corresponds to an elastic distribution of stresses at any moment after loading of the model

of the same sheet of stock as the model and has been subjected to the same annealing treatment. If the applied load is to be compressive, a disk in diametral compression is suggested as the calibration member, while a tensile load is best calibrated by a beam in pure bending, as has been suggested by Norris[3]. It is usually more convenient to work with a constant deformation than with a constant load when using the autocalibration technique. The little additional time required to prepare and use the calibration specimen, in those cases where it is indicated, is a small payment to make for the advantages offered by the inexpensive prepolished material.

Determining Fractional Fringe Order

BIREFRINGENCE COMPENSATION: There are many times when an accurate measurement of the fringe order at a single point will provide all of the information desired. In such cases, some method of compensation is indicated for the precise determination of the fractional fringe order. The authors have found the method originally due to Tardy[4] and described in detail[5] to be convenient for this purpose. Briefly, this method consists in placing one axis of the polarizer parallel to one of the principal stress directions at the point where the fringe order is to be determined and rotating the analyzer until extinction is obtained at the point. The fractional fringe order is then given by the fraction of 180 degrees (measured from the position in which analyzer and polarizer are crossed) through which the analyzer must be turned to produce the extinction.

While the paper mentioned[5] contains explicit directions for determining whether the fractional fringe order, as measured, is to be added to or subtracted from the order determined by counting in the normal crossed polaroid arrangement, it is often easier to turn the anlyzer in a direction, determined by trial, which will cause the fringes to appear to move in the same direction as they do when the load is increased slightly. Increments determined in this way are to be subtracted from the integral order next above the point in question. This method of compensation is particularly suited for points on the boundary or on an axis of symmetry where the principal stress directions are known.

While it may be possible for a highly skilled operator to produce results with the conventional Nicol prism or Polaroid polariscope and models of Bakelite BT 61-893, which are superior to those attainable by the use of the diffused-light polariscope and techniques discussed, the authors believe that the industrial photoelastician will find advantages in using this new method.

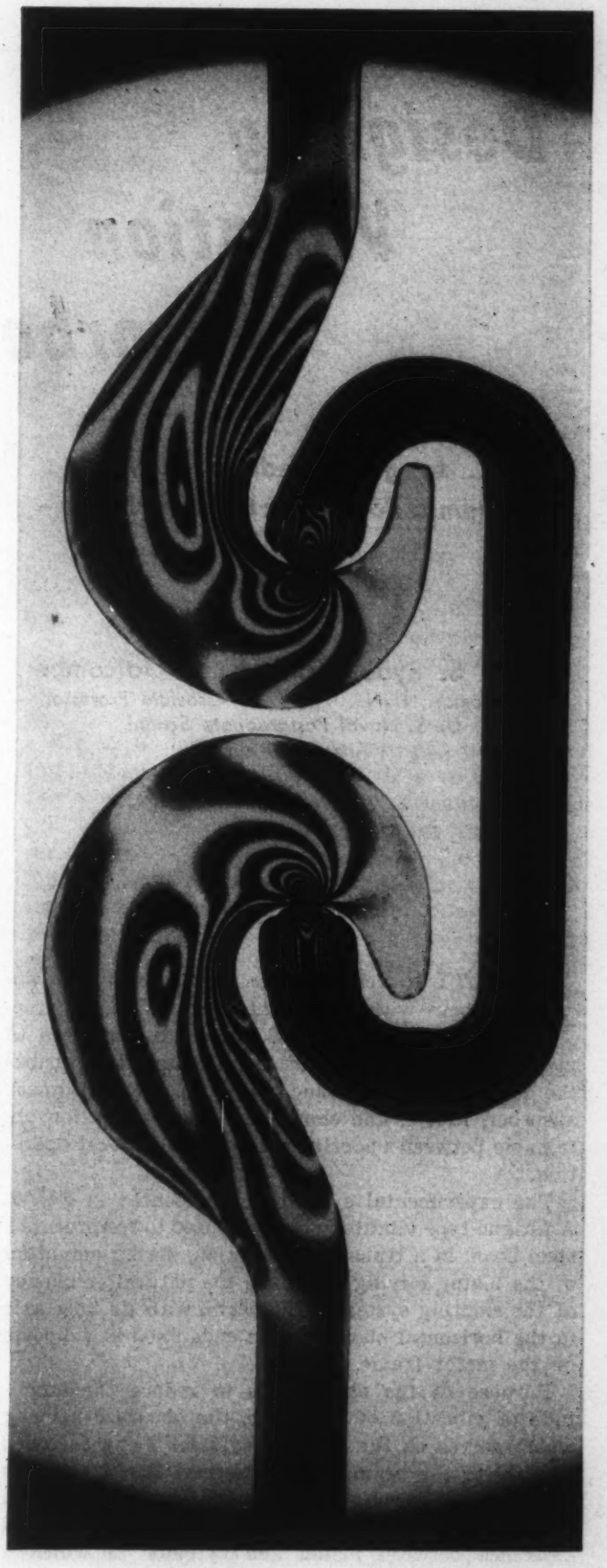


Fig. 7—Two designs for hooks. Top one is 15 per cent lighter than the bottom design. The maximum stress is the same in each case. The fringe order in each shank is two and since the stress there is uniform, the specimens are autocalibrating. No knowledge of the optical sensitivity is required when stress in a section is known

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Designing Vibration Absorbers

. . . to give predictable linear dynamic damping characteristics

By H. S. Ryder* and E. K. Gatcombe
Lt. Comdr., USN *Associate Professor*
U. S. Naval Postgraduate School
Annapolis, Md.

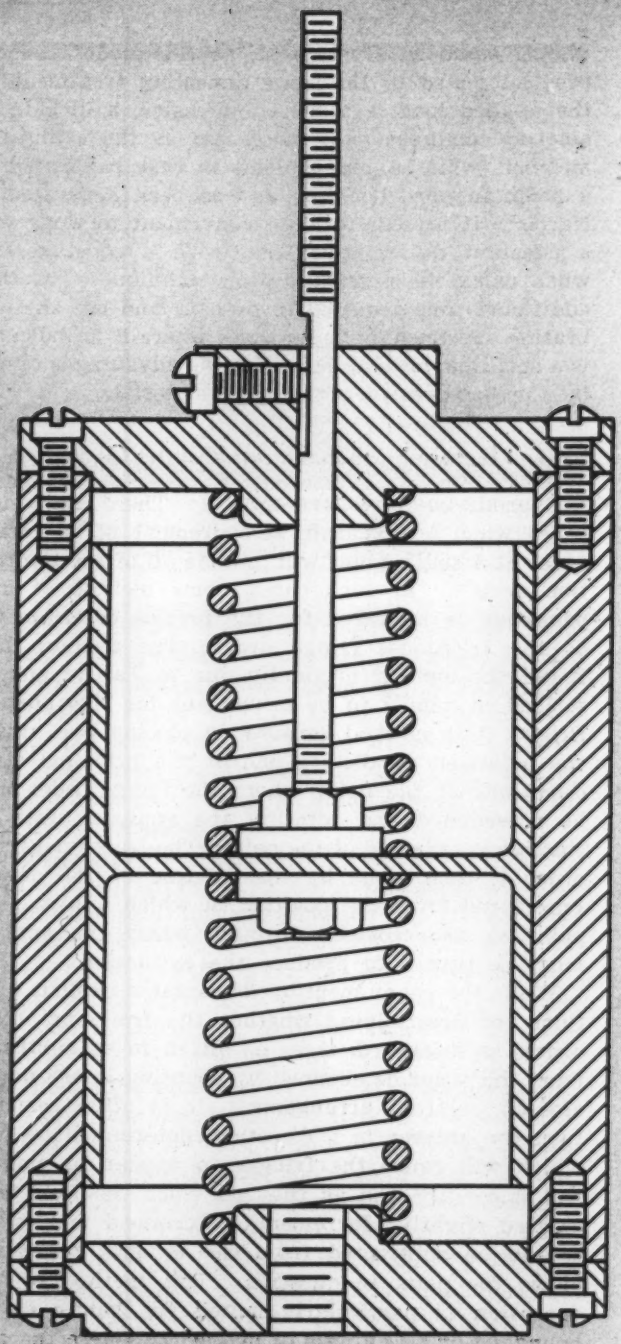


Fig. 1—Linear damped vibration absorber showing simple arrangement of piston, housing and absorber springs. Damping piston has 1.5-inch bore and 2¾-inch length, with radial oil- film clearance between piston and housing of approximately 0.002-inch

ABILITY to design linear damped vibration absorbers with predictable performance characteristics is a valuable asset to designers of machinery subject to vibration. This article describes the design, fabrication and testing of one such linear absorber, *Fig.* 1, and shows the close correlation obtainable between underlying theory and actual operation.

The experimental system is represented in *Fig.* 2. A fatigue type vibratory motor is used to reciprocate a steel beam in a transverse direction, spring mounting of the motor serving to reduce the natural frequency of the exciting system. The beam, with its long axis in the horizontal plane, has its ends fixed in supports on the motor frame.

Purpose of the absorber is to reduce the amplitude of vibration of the beam, the absorber housing which serves as the dashpot cylinder being fastened directly to the beam. The absorber, *Fig.* 1, consists of the housing containing a piston supported by two helical springs in compression, with a small radial clearance between piston and cylinder in which a thin film of lubricating oil serves as the damping medium.

From the schematic representation in *Fig.* 3 it can be seen that the following two differential equations indicate the state of motion of the two masses M and m, under damping and forced vibration conditions, in a two-degree-of-freedom system:

$$M\frac{d^2x_1}{dt^2} + Kx_1 + k(x_1 - x_2) + b\frac{dx_1}{dt} + c\left(\frac{dx_1}{dt} - \frac{dx_2}{dt}\right) = P_o\sin\omega t \quad \ldots\ldots (1)$$

$$m\frac{d^2x_2}{dt^2} + k(x_2 - x_1) + c\left(\frac{dx_2}{dt} - \frac{dx_1}{dt}\right) = 0 \quad \ldots\ldots (2)$$

* Now stationed at Pearl Harbor Naval Yard Base.

where the symbols are defined in *Fig.* 3 and in the Nomenclature.

If useful practical design information is to be obtained, Equations 1 and 2 must be solved and the correct functional relationship between the several variables established. The detailed steps in the steady-state solution of these two simultaneous equations may be found in several texts. One such solution[1] is:

$$\frac{x_1}{x_o} = \sqrt{\frac{(2hg)^2 + (g^2 - f^2)^2}{(2hg)^2[g^2 - 1 + \mu g^2 + \mu\, b/c\,(g^2 - f^2)] + [\mu f^2 g^2 - (g^2 - 1)(g^2 - f^2) + 4\mu h g^2\, b/c_c]^2}} \quad (3)$$

It was found, through analysis of photographs of the die-away wave form of the motion of the vibrating beam with the piston of the absorber locked, that the motor damping constant, b, could affect the results of the test only slightly. Considering, then, that $b = 0$, Equation 3 may be written as

$$\frac{x_1}{x_o} = \sqrt{\frac{(2hg)^2 + (g^2 - f^2)^2}{(2hg)^2(g^2 - 1 + \mu g^2)^2 + [\mu f^2 g^2 - (g^2 - 1)(g^2 - f^2)]^2}} \quad \ldots\ldots (4)$$

For such a system operating under specified conditions, the dimensionless quantities h, f, and μ may be considered as constants, and the frequency ratio, g, as the independent variable. The amplitude ratio, x_1/x_o may then be considered a function of g only. It is shown by Den Hartog[1] that the condition for optimum tuning is expressed by

$$f = \frac{1}{1 + \mu} \quad \ldots\ldots (5)$$

[1] References listed at end of article.

Nomenclature

- b = Main system damping constant
- c = Absorber system damping constant
- c_c = (Pseudo) critical damping constant of absorber system = $2m\Omega_n$
- f = Tuning ratio = ω_a/Ω_n
- g = Driving frequency ratio = ω/Ω_n
- h = Damping ratio = c/c_c
- K = Main system spring constant
- k = Absorber system spring constant
- M = Mass of main system
- m = Mass of absorber system
- P_o = Maximum value of exciting force
- t = Time
- x_1 = Displacement of main mass from neutral position
- x_2 = Displacement of absorber mass from neutral position
- x_o = Static deflection of main system = P_o/K
- μ = Mass ratio = m/M
- Ω_n = Damped natural frequency of main system = $\sqrt{K/M}$
- ω = Driving frequency
- ω_a = Undamped natural frequency of absorber system = $\sqrt{k/m}$

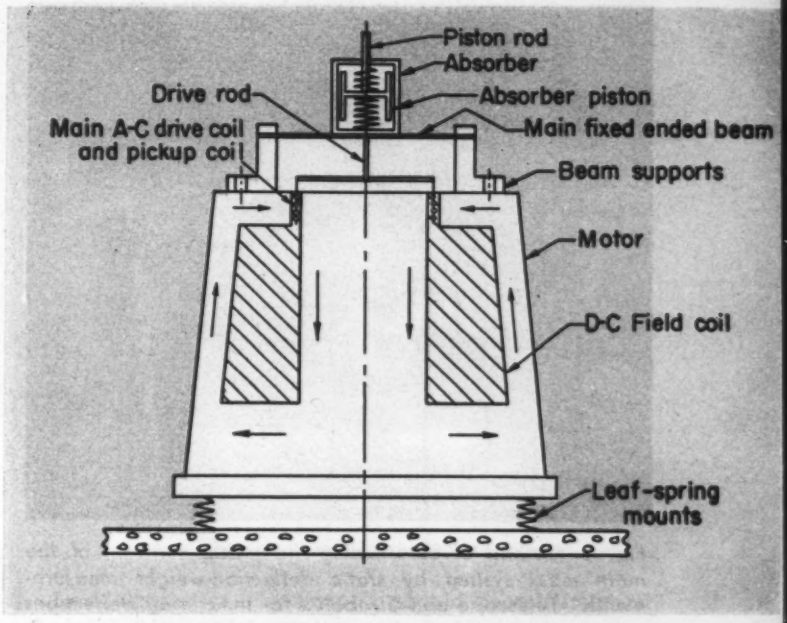


Fig. 2—Schmatic drawing giving arrangement of test set-up. Absorber housing can be seen attached to beam

If $c = 0$, damping force is zero and the resonant amplitude is infinite. Likewise, if $c = \infty$, relative displacement is zero and again resonant amplitude will be infinite. Somewhere between these two c values there is a damping for which the product of damping force and displacement is a maximum, giving minimum resonant amplitude. This value of c is known as *optimum* damping. On the other hand *constant* damping or tuning exists when the damper is tuned to the same frequency as the main system, regardless of the size of the damper.

For optimum tuning the absorber should be tuned below the natural frequency of the main mass system. A good damping constant for optimum tuning is given by Brock as follows:[2]

$$h^2 = \frac{3\mu}{8(1 + \mu)^3} \quad \ldots\ldots (6)$$

As part of the preliminary calculation and setup work, the main mass, M, was obtained and then

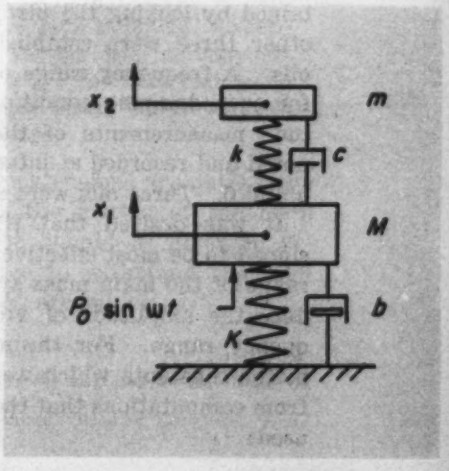


Fig. 3—Equivalent elastic system shown without foundation spring mounts. Dashpot (c) represents absorber damping; dashpot (b) represents internal damping of main system

Fig. 4—Method of determining the spring constant of the main mass system by static deflection-weight measurements. Telescope and Strobolux for measuring deflections are shown at the right

checked experimentally by noting the natural frequency of the set-up, the mass checking within one per cent. The absorber mass, m, consisted of the mass of the piston plus inertia effect of its two springs. The spring constant, K, of the main mass system was obtained by static deflection-weight measurements, *Fig.* 4, the main spring constant including the spring constant of the drive coil guide springs. The value of k was likewise determined. Both springs were nearly linear.

Relative amplitudes of vibration of the beam were measured using a signal pickup coil attached to the spider which carried the drive coil. The spider reciprocated vertically and vibrated the beam at frequencies and amplitudes controlled by an oscillator and amplifier, respectively.

Procedure In Testing

Two types of tests were devised to check the design of the absorber against theory, one based on constant tuning ($f = 1$), and the other on optimum tuning ($f = 1/1+\mu$). Four different damping conditions were maintained during each of these two sets of tests. One of these damping conditions was obtained by locking the piston (infinite damping). The other three were established by means of different oils. A frequency range of 26 to 96 cps was covered for each damping condition in each test set. Amplitude measurements of the main mass system were noted and recorded at intervals of g as shown in *Figs.* 5 and 6. Three oils were used as listed in TABLE 1.

It was desired that the absorber should be designed to be most effective near the natural frequency range of the main mass system and that it should reduce the amplitude of vibration over a certain frequency range. For the size of the main beam and motor constants which were to be used, it was found from computations that the following values should be used:

For constant tuning ($f = 1$)

$K = 1490$ lb per inch
$M = 4.193$ lb/g
$\Omega_n = \omega_a = 370.4$ radians per sec. $= 59.0$ cps
$k = 83.5$ lb per inch
$m = 0.2349$ lb/g
$\mu = m/M = 0.0560$

For optimum tuning ($f = 1/1 + \mu$)

$m = 0.2657$ lb/g
$\mu = 0.0633$
$f = 0.9404$
$\omega_a = f\Omega_n = 348.3$ radians per sec $= 55.5$ cps

It will be noted that for constant tuning $m = 0.2349/g$ and for optimum tuning $m = 0.2657/g$, a difference of 0.0308 lb or 14 grams. Thus, the system may be changed from one of constant tuning to that of optimum tuning by merely adding 14.0 grams to the mass of the absorber piston.

Curves for constant tuning condition: When $f = 1$ and $c = \infty$, Equation 3 reduces to

$$\frac{x_1}{x_o} = \sqrt{\frac{1}{(g^2 - 1 + \mu g^2)^2 + (2\mu g\, b/c_c)^2}} \qquad \ldots\ldots\ldots (7)$$

It is observed that the curve of test results for the piston locked condition, *Fig.* 5, agrees well with the curve of theoretical values as computed by Equation 7. The three other curves of *Fig.* 5 for oils NS 1065, NS 2135 and NS 3042 agree well in character with

Fig. 5—Curves for constant tuning condition. Tuning ratio, $f = 1$; mass ratio, $\mu = 0.0560$

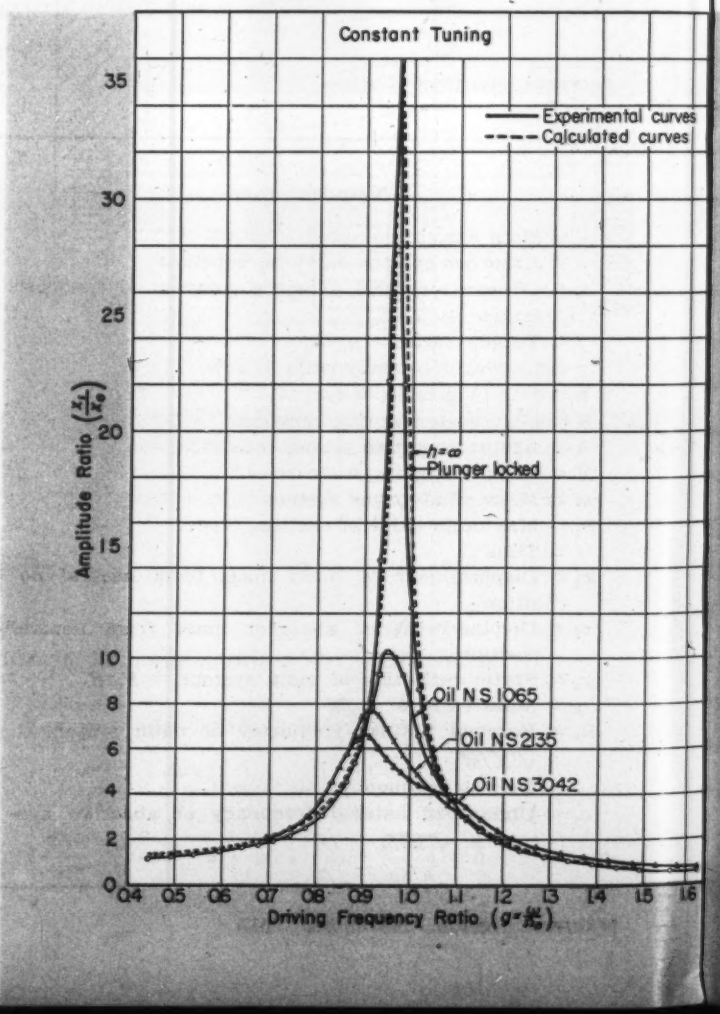


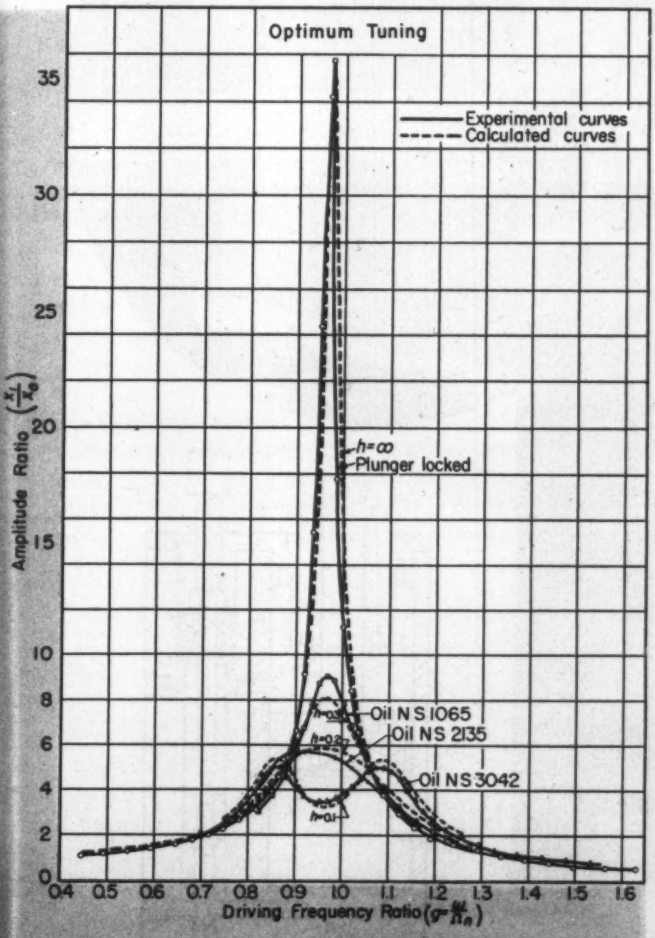
Table 1—Viscosity of Damping Oils

Designation	Viscosity (Saybolt Universal Seconds) at 100 F	at 130 F	at 210 F
NS 3042	150	85	43.3
NS 2135	286	137	50.7
NS 1065	538	243	67.5

the theoretical curves. The curve of NS 1065 representing the action of a relatively heavy oil has a single peak effect. So does that of oil NS 2135 which is the next most viscous oil. The curve of the action of the least viscous oil, NS3042, begins to indicate a two peak effect. In each case all curves nearly pass through the characteristic points at which damping theoretically has no effect on amplitude ratio.[1, 2]

Curves for optimum tuning condition: The optimum tuning and damping effects are well shown in *Fig.* 6, where four experimental and four theoretical curves are plotted. The two curves with the relatively large ordinates represent the case of the piston locked (infinite damping). The next lower set of curves, ($h = 0.3$), represent experimental and calculated results. The set for which $h = 0.2$ represents more or less the transfer region from a single peak condition to a double peak. Finally, the curves for $h = 0.1$ definitely have a saddle effect with the two peaks coming at nearly the same elevation. This completely corresponds with the theoretical prediction for the case of optimum tuning and damping. Note also that the curve nearly passes through the characteristic points at which damping has no effect.

Fig. 6—Curves for optimum tuning condition. Predicted and actual curves agree well for the four damping ratios tested. Tuning ratio, $f = 0.9404$; mass ratio, $\mu = 0.0633$



Curves shown in *Figs.* 5 and 6 indicate that these linear-damped dynamic vibration absorbers can be designed to give performance characteristics which agree well with theory. These results show that machines with properly designed absorbers can be operated through the critical speed range with relatively low amplitudes of vibration, but that the absorber is useful only in a certain range of operation. Value of the absorber is demonstrated by the relative amplitudes of vibration of the beam for frequencies near the critical, as shown in *Figs.* 5 and 6. With even lighter oil and optimum tuning the absorber would permit the beam to vibrate with almost no detectable amplitude even at the critical frequency.

Design Considerations

In designing an absorber, it should be remembered that if a piston is to reciprocate rapidly with respect to a cylinder, with a thin film of oil separating the two, there will be a limit to the practical minimum radial clearance value. If the absorber is designed with clearance values below this practical value, the piston will not function properly in its cylinder. Similarly there is an upper practical limit on this clearance value. To achieve control of the damping constant a wide range of lubricants, with varying viscosities, may be used. The materials used in the piston and cylinder impose no special problems other than that they shall have good machining, grinding, and hardening properties. The springs may be made of any suitable spring material.

The following specific points should be kept in mind in designing an absorber:

1. Decide upon a certain desired amplitude ratio for x_1/x_{st} for operations over a certain frequency range. (This step will fix the ratio of c/c_c).
2. Remember that optimum tuning and damping will function to give the smallest relative amplitude ratios through the critical range.
3. Determine K, M, Ω_n, k and m for the two systems.
4. Use the theory as a guide in determining a desirable value of c, fix upon a practical radial clearance value (approximately one and one-half thousandths per inch of diameter), and then try one or two different viscosity oils; i.e., let the oil be the factor which can be easily varied. A light oil will furnish the necessary damping. Experience indicates that the viscous drag actually experienced by the piston is greater than that found by the simple laminar flow theory for frequencies in the neighborhood of 60 cps.

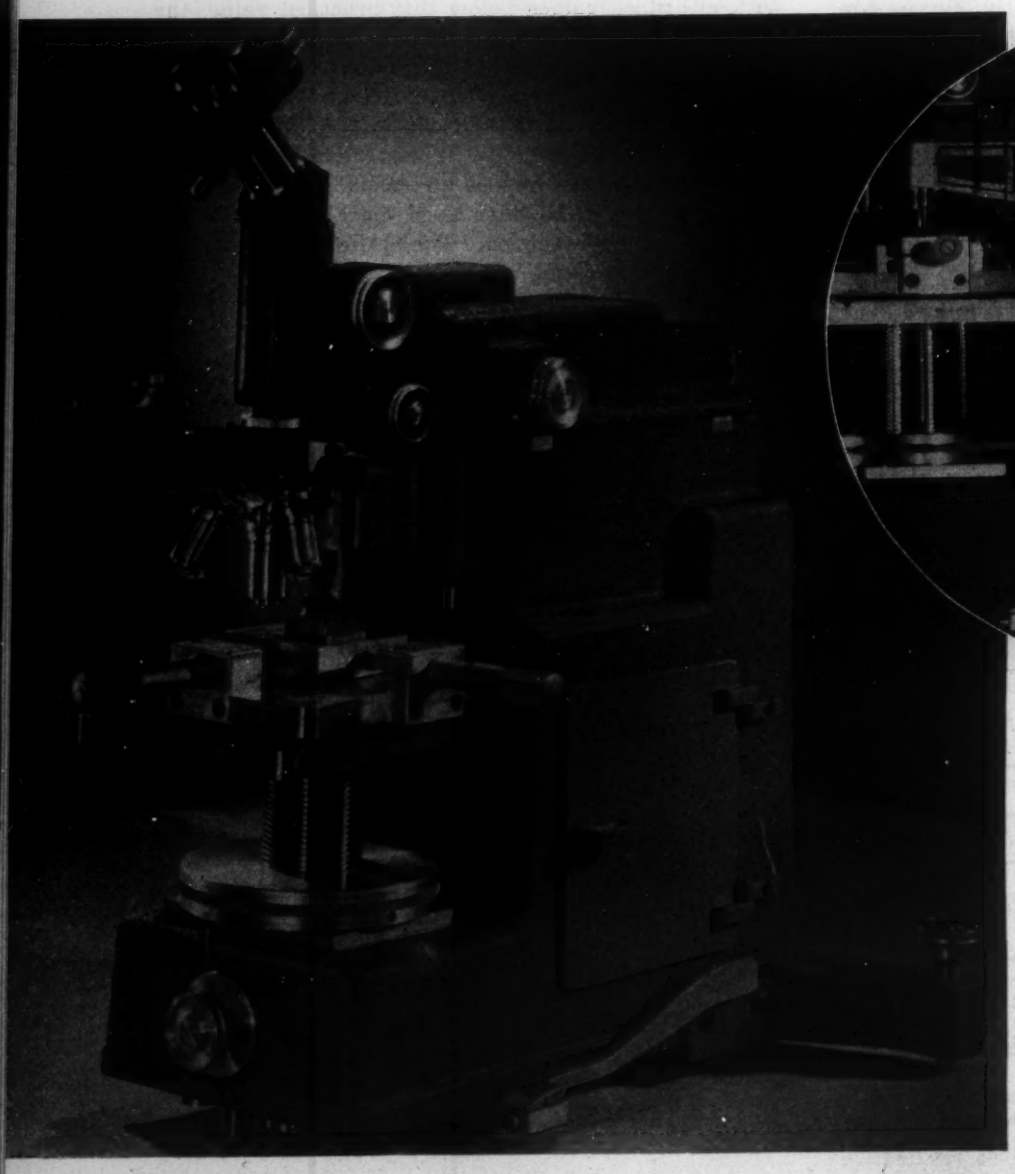
Since the absorber spring extensions are quite large (several times as large as the motion of the main system) particular attention should be given to designing the absorber springs to withstand the high fatigue stresses to which they are subjected.

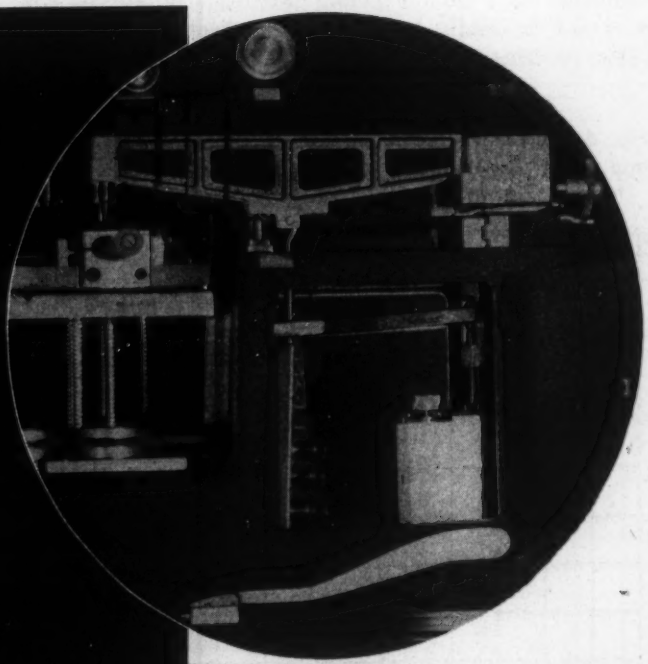
References

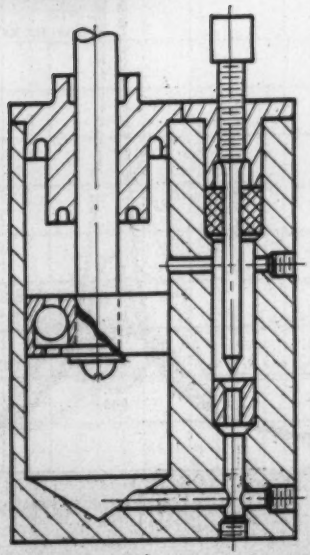
1. J. P. Den Hartog, *Mechanical Vibrations*, McGraw-Hill Book Co. Inc., New York.
2. J. E. Brock, "A Note on the Damped Vibration Absorber", *Trans. ASME*, 1946.

Contemporary DESIGN

Hardness Testing With Precision Indenter







CONTROLLED indentation speeds and a unique unloading linkage contribute to the precision operation of the indenture type microhardness tester shown in the photograph, far left. Hand operated, the tester is designed for measuring Knoop and Vickers indentations by means of a microscope and filar micrometer eyepiece.

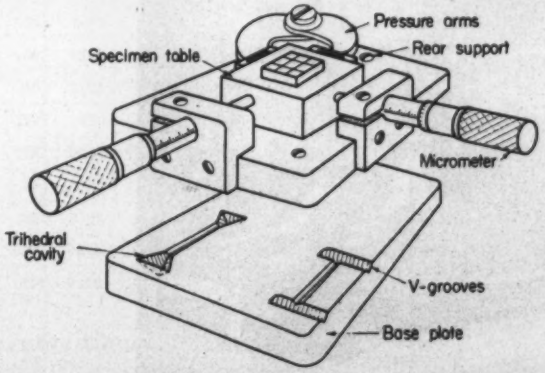
The loaded indenter is lowered into the specimen by a dashpot-controlled beam, seen in the composite photograph, left, until the material under test supports the entire load. The beam is supported by a set of sensitive vertical flexure plates which afford the necessary precision in adjusting for the stable equilibrium position of the beam prior to loading. This beam mounting assures that no friction or other effect in the beam support system will introduce variations to the load being applied.

A wide range of dashpot speeds, controlled by the needle valve shown in the cross section drawing of the dashpot, lower left, permits selection of a beam lowering rate that will introduce no detectable impact effect on the specimen. The linkage between operating lever, beam and dash pot allows the indenter to be lifted clear of the indentation before the dashpot components are lifted, so that the inertia effect of suddenly moving a relatively large mass within the machine does not tend to enlarge or blur the indentation.

Optical equipment shown on the machine consists of a metallurgical microscope with illumination features, a triple nose piece with 16, 10.25 and 4-mm objectives, and a filar micrometer eyepiece. Hardness can be found from indentations small as 0.07-micron.

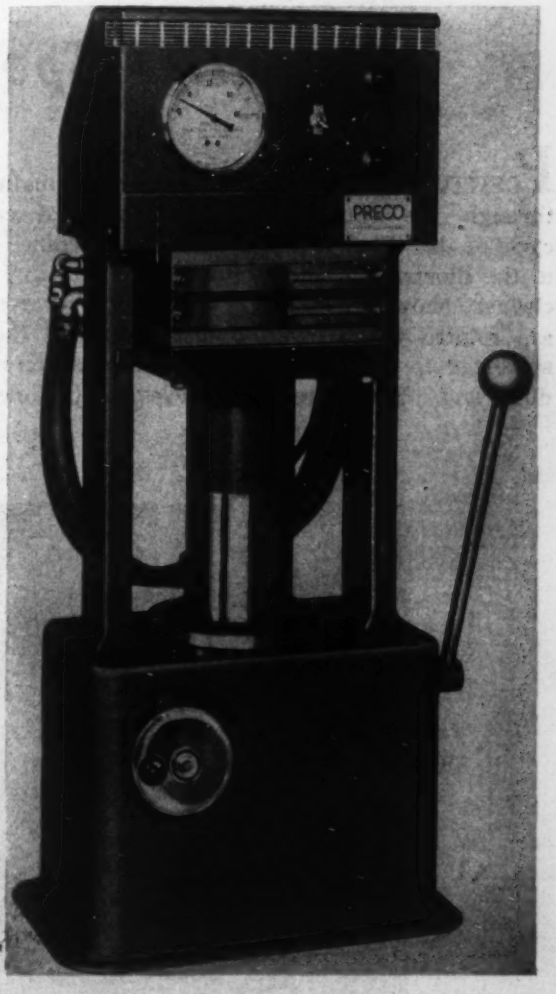
The specimen stage, seen in the drawing below, is supported by a base plate mounted on the elevating screw. There are only two possible positions of the base plate, both accurately determined by a simple three-point suspension. In the forward position the specimen is adjusted for indentation location by means of the two micrometers. To make the indentation, the stage is manually moved to the rear position, on a line normal to the optical and penetrater axes, a distance precisely equal to the distance between these axes. In the rear position, the indenter axis coincides with the point on the specimen that was previously in the optical axis of the microscope. After the indentation is made, the stage is shifted back to the forward position for measurement.

Dead weight loads of 1 to 1000 grams may be applied in increments of 1 gram, and specimens approximately 2¾ inches in height may be tested. Manufacturer: Kent Cliff Laboratories, Peekskill, N. Y.



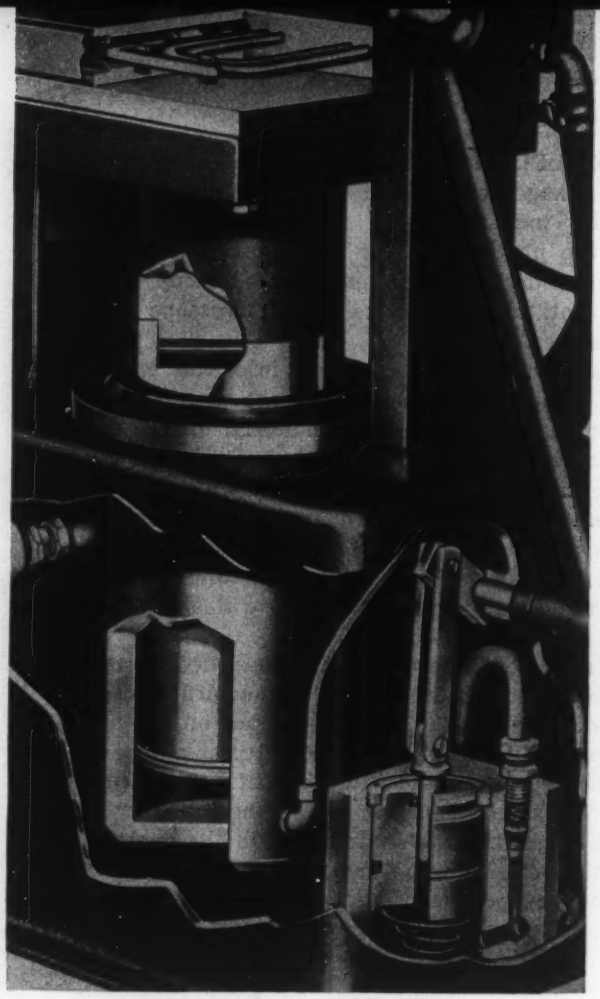
Two-Stage Pump Operates Press

TWO different operating pressures from the same pump are available in the hand-operated, bench type hydraulic press shown in the photograph below. Developing up to 40,000 pounds pressure, the two-stage pump incorporates a piston within another piston, as seen at the lower right in the cutaway drawing, top next page, with a displacement ratio of 16 to 1. An operating handle is direct-connected to the inner, high-pressure piston which operates independently of the



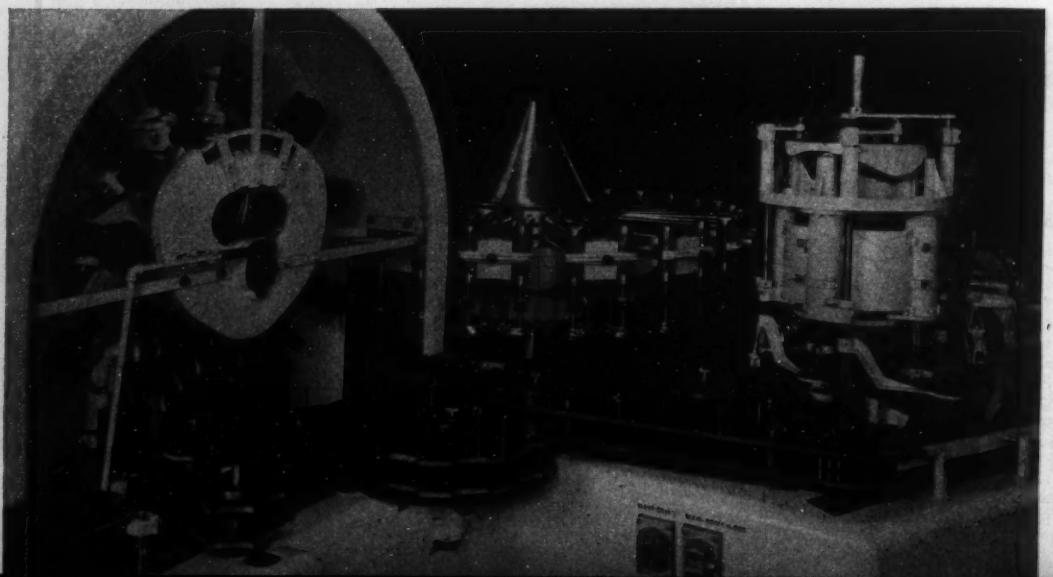
larger piston through the upper half of the handle stroke. For lower half of the stroke, the small piston engages the larger piston and both move together. Rapid press closure is accomplished using the lower handle travel and maximum press force is obtained using the upper handle stroke.

The exhaust check valve on the pump is a cone type poppet valve using an O-ring seal. A gravity return is used on the single-acting ram, with the return speed of the platen controlled by a pressure-relief valve on the lower press housing. A rubber cushion, installed under the lower platen and at the top of the ram, allows the lower platen to level itself in relation to the upper platen. The press is equipped with electrically heated and water cooled platens. Heating elements providing up to 600 F temperatures and steel tube cooling coils are cast directly into both upper and lower platens: Platen sizes are 8 by 8 or 8¾ by 12 inches. Manufacturer: Preco Inc., Los Angeles, Calif.



High-Speed Bottle Filler

POSITIVE control of glass bottles is maintained through the entire cleaning, filling and capping cycle of the "Close-Coupled" bottling machines shown in the illustration below. Bottles fed into the rotary cleaner, shown at the left with the cover removed, are rotated to an inverted position where they are subjected to an internal blast of dry air to remove dust and other foreign particles. After cleaning bottles are filled on a 30-head rotary vacuum filler, center, which permits close control of filling heights by turning of a handwheel, and are then fed to the four-head capper shown at the right. This set-up has a guaranteed minimum speed of 120 quart bottles per minute and can be connected to the intake conveyor of a labeling machine. Manufacturer: Pneumatic Scale Corp. Ltd., North Quincy, Mass.



Tables Aid Solution of Beam Deflection Problems

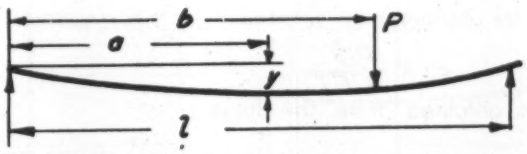
By J. D. Swannack
Chief Design Calculator
Fairbanks, Morse & Co.
Beloit, Wis.

DEFLECTION at any point on a loaded beam may be rapidly determined with the aid of tables presented in this data sheet. To use the tables, the values of K therein are substituted in the appropriate equation given at the head of each table. In the equations, P is the load, lb; l is the length, inches; E is the modulus of elasticity in tension, psi; I is the section moment of inertia, in^4; and y is the deflection, inches.

The three tables are actually matrices of influence coefficients, in which a certain numerical symmetry will be observed—a demonstration of Rayleigh-Maxwell reciprocal relations. The numbers in any one row are the deflection coefficients at that point for loads at different points along the beam. The numbers in any one column are the deflection coefficients for different points along the beam due to a load at the particular location.

Length increment has been taken as $l/20$, which may necessitate occasional interpolation. Linear interpolation is adequate in regions where the numbers are changing slowly, for example, in the middle of

Table 1—Deflection Factors, K, for Simply Supported Beam



To solve for deflection y substitute in the equation

$$y = K\frac{Pl^3}{48EI}$$

where K is obtained from the table

	Ratio of b/l																		
a/l	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95
.05	.0361	.0675	.0935	.1144	.1305	.1421	.1495	.1530	.1529	.1495	.1431	.1340	.1225	.1089	.0935	.0766	.0585	.0395	.0199
.10	.0675	.1296	.1819	.2240	.2565	.2800	.2951	.3024	.3025	.2960	.2835	.2656	.2429	.2160	.1855	.1520	.1161	.0784	.0395
.15	.0935	.1819	.2601	.3240	.3735	.4095	.4329	.4446	.4455	.4365	.4185	.3924	.3591	.3195	.2745	.2250	.1719	.1161	.0585
.20	.1144	.2240	.3240	.4096	.4770	.5264	.5590	.5760	.5786	.5680	.5454	.5120	.4690	.4176	.3590	.2944	.2250	.1520	.0766
.25	.1305	.2565	.3735	.4770	.5625	.6265	.6695	.6930	.6985	.6875	.6615	.6220	.5705	.5085	.4375	.3590	.2745	.1855	.0935
.30	.1421	.2800	.4095	.5264	.6265	.7056	.7605	.7920	.8019	.7920	.7641	.7200	.6615	.5904	.5085	.4176	.3195	.2160	.1089
.35	.1495	.2951	.4329	.5590	.6695	.7605	.8281	.8694	.8855	.8785	.8505	.8036	.7399	.6615	.5705	.4690	.3591	.2429	.1225
.40	.1530	.3024	.4446	.5760	.6930	.7920	.8694	.9216	.9460	.9440	.9180	.8704	.8036	.7200	.6220	.5120	.3924	.2656	.1340
.45	.1529	.3025	.4455	.5786	.6985	.8019	.8855	.9460	.9801	.9855	.9639	.9180	.8505	.7641	.6615	.5454	.4185	.2835	.1431
.50	.1495	.2960	.4365	.5680	.6875	.7920	.8785	.9440	.9855	1.0000	.9855	.9440	.8785	.7920	.6875	.5680	.4365	.2960	.1495
.55	.1431	.2835	.4185	.5454	.6615	.7641	.8505	.9180	.9639	.9855	.9801	.9460	.8855	.8019	.6985	.5786	.4455	.3025	.1529
.60	.1340	.2656	.3924	.5120	.6220	.7200	.8036	.8704	.9180	.9440	.9460	.9216	.8694	.7920	.6930	.5760	.4446	.3024	.1530
.65	.1225	.2429	.3591	.4690	.5705	.6615	.7399	.8036	.8505	.8785	.8855	.8694	.8281	.7605	.6695	.5590	.4329	.2951	.1495
.70	.1089	.2160	.3195	.4176	.5085	.5904	.6615	.7200	.7641	.7920	.8019	.7920	.7605	.7056	.6265	.5264	.4095	.2800	.1421
.75	.0935	.1855	.2745	.3590	.4375	.5085	.5705	.6220	.6615	.6875	.6985	.6930	.6695	.6265	.5625	.4770	.3735	.2565	.1305
.80	.0766	.1520	.2250	.2944	.3590	.4176	.4690	.5120	.5454	.5680	.5786	.5760	.5590	.5264	.4770	.4096	.3240	.2240	.1144
.85	.0585	.1161	.1719	.2250	.2745	.3195	.3591	.3924	.4185	.4365	.4455	.4446	.4329	.4095	.3735	.3240	.2601	.1819	.0935
.90	.0395	.0784	.1161	.1520	.1855	.2160	.2429	.2656	.2835	.2960	.3025	.3024	.2951	.2800	.2565	.2240	.1819	.1296	.0675
.95	.0199	.0395	.0585	.0766	.0935	.1089	.1225	.1340	.1431	.1495	.1529	.1530	.1495	.1421	.1305	.1144	.0935	.0675	.0361

Data Sheet

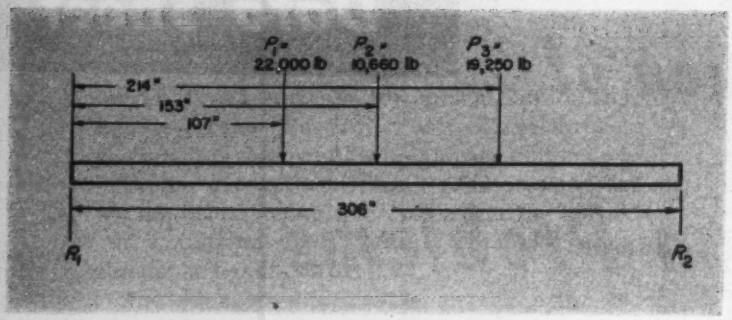


Fig. 1—Loads on center span of switcher locomotive

TABLE 1. Where the numbers change rapidly more elaborate interpolation formulas may be used, but it is simpler and faster to plot a few points on graph paper.

MULTIPLE LOADS: Although the sketches show only single concentrated loads, the tables may be applied to beams with multiple loads. The following example illustrates the technique employed.

Example 1. Shown in *Fig.* 1 is the center span of a switcher locomotive underframe with three of the more important loadings. The material being steel, $E = 30 \times 10^6$ psi; also, the dimensions are such that $I = 5885$ in.^{4}

The formula for deflection is written

$$y = \frac{l^3}{48EI}(K_1P_1 + K_2P_2 + K_3P_3) \quad \ldots\ldots\ldots\ldots (1)$$

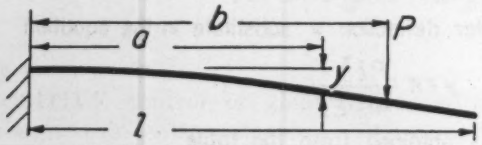
At the center of the beam (under P_2) $a/l = 0.5$, and the three values of b/l are, respectively, $107/306 = 0.35$; $153/306 = 0.5$; and $214/306 = 0.7$. The corresponding values of K are, from the table, $K_1 = 0.8785$; $K_2 = 1.000$; and $K_3 = 0.7920$. Substituting in Equation 1,

$$y_2 = \frac{306^3}{48 \times 30 \times 10^6 \times 5885}[0.8785 \times 22{,}000 + 1 \times 10{,}660 + 0.7920 \times 19{,}250] = 0.153\text{-in.}$$

DISTRIBUTED LOADS: The tables may also be used to solve distributed load problems. To demonstrate the method a beam built in at both ends and with uniform load w per unit length will be considered. Inasmuch as the formula for deflection at the center of this type of beam is known, the validity of the method can be checked. The uniform load can be assumed equivalent to 19 individual loads each equal to $P = wl/20$. The numbers in the row for $a/l = 0.50$ in TABLE 3 are added and found to total 10. The deflection formula is then

$$y = \frac{l^3}{192\,EI}\Sigma PK = \frac{l^3}{192\,EI} \times \frac{wl}{20} \times 10 = \frac{w\,l^4}{384\,EI} = \frac{W\,l^3}{384\,EI}$$

Table 2—Deflection Factors, K, for Uniform Cantilever Beam



To solve for deflection y substitute in the equation

$$y = K\frac{Pl^3}{3EI}$$

where K is obtained from the table

	Ratio of b/l																			
a/l	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	1.00
.05	.0001	.0003	.0005	.0007	.0009	.0011	.0012	.0014	.0016	.0018	.0020	.0022	.0024	.0026	.0028	.0029	.0031	.0033	.0035	.0037
.10	.0003	.0010	.0018	.0025	.0032	.0040	.0048	.0055	.0062	.0070	.0078	.0085	.0092	.0100	.0108	.0115	.0122	.0130	.0138	.0145
.15	.0005	.0018	.0034	.0051	.0068	.0084	.0101	.0118	.0135	.0152	.0169	.0186	.0202	.0219	.0236	.0253	.0270	.0287	.0304	.0321
.20	.0007	.0025	.0051	.0080	.0110	.0140	.0170	.0200	.0230	.0260	.0290	.0320	.0350	.0380	.0410	.0440	.0470	.0500	.0530	.0560
.25	.0009	.0032	.0068	.0110	.0156	.0203	.0250	.0297	.0344	.0391	.0438	.0484	.0531	.0578	.0625	.0672	.0719	.0766	.0812	.0859
.30	.0011	.0040	.0084	.0140	.0203	.0270	.0338	.0405	.0472	.0540	.0608	.0675	.0742	.0810	.0878	.0945	.1012	.1080	.1148	.1215
.35	.0012	.0048	.0101	.0170	.0250	.0338	.0429	.0521	.0612	.0704	.0796	.0888	.0980	.1072	.1164	.1256	.1348	.1439	.1531	.1623
.40	.0014	.0055	.0118	.0200	.0297	.0405	.0521	.0640	.0760	.0880	.1000	.1120	.1240	.1360	.1480	.1600	.1720	.1840	.1960	.2080
.45	.0016	.0062	.0135	.0230	.0344	.0472	.0612	.0760	.0911	.1063	.1215	.1367	.1519	.1671	.1822	.1974	.2126	.2278	.2430	.2582
.50	.0018	.0070	.0152	.0260	.0391	.0540	.0704	.0880	.1063	.1250	.1438	.1625	.1812	.2000	.2188	.2375	.2562	.2750	.2938	.3125
.55	.0020	.0078	.0169	.0290	.0438	.0608	.0796	.1000	.1215	.1438	.1664	.1891	.2118	.2344	.2571	.2798	.3025	.3252	.3479	.3706
.60	.0022	.0085	.0186	.0320	.0484	.0675	.0888	.1120	.1367	.1625	.1891	.2160	.2430	.2700	.2970	.3240	.3510	.3780	.4050	.4320
.65	.0024	.0092	.0202	.0350	.0531	.0742	.0980	.1240	.1519	.1812	.2118	.2430	.2746	.3063	.3380	.3697	.4014	.4331	.4648	.4964
.70	.0026	.0100	.0219	.0380	.0578	.0810	.1072	.1360	.1671	.2000	.2344	.2700	.3063	.3430	.3798	.4165	.4532	.4900	.5268	.5635
.75	.0028	.0108	.0236	.0410	.0625	.0878	.1164	.1480	.1822	.2188	.2571	.2970	.3380	.3798	.4219	.4641	.5062	.5484	.5906	.6328
.80	.0029	.0115	.0253	.0440	.0672	.0945	.1256	.1600	.1974	.2375	.2798	.3240	.3697	.4165	.4641	.5120	.5600	.6080	.6560	.7040
.85	.0031	.0122	.0270	.0470	.0719	.1012	.1348	.1720	.2126	.2562	.3025	.3510	.4014	.4532	.5062	.5600	.6141	.6683	.7225	.7767
.90	.0033	.0130	.0287	.0500	.0766	.1080	.1439	.1840	.2278	.2750	.3252	.3780	.4331	.4900	.5484	.6080	.6683	.7290	.7898	.8505
.95	.0035	.0138	.0304	.0530	.0812	.1148	.1531	.1960	.2430	.2938	.3479	.4050	.4648	.5268	.5906	.6560	.7225	.7898	.8574	.9251
1.00	.0037	.0145	.0321	.0560	.0859	.1215	.1623	.2080	.2582	.3125	.3706	.4320	.4964	.5635	.6328	.7040	.7767	.8505	.9251	1.0000

where $W = wl$ = total load on beam. The result happens to agree with the exact equation in this instance.

Example 2. The beam in *Fig.* 2 has a very general type of distributed load. Dividing the beam into equal subdivisions each one-twentieth of the length, the load intensity at each station is as indicated in *Fig.* 2. The load P at each point is the load intensity times the length of the increment (360/20 = 18 in.). Thus, $P_1 = 70 \times 18 = 1260$ lb, $P_2 = 125 \times 18 = 2250$ lb, etc. For this beam the deflection formula becomes

$$y = \frac{l^3}{48\,EI}\,\Sigma PK \qquad (2)$$

where ΣPK is the sum of the products of P at each station and the value of K corresponding to the value of b/l at that point. If the center deflection is required, values of b/l are taken for the row $a/l = 0.50$, with the following result:

b	b/l	w	$P=18w$	K	PK
126	0.35	70	1260	0.8785	1110
144	0.40	125	2250	0.9440	2120
162	0.45	180	3240	0.9855	3190
180	0.50	220	3960	1.0000	3960
198	0.55	250	4500	0.9855	4430
216	0.60	270	4860	0.9440	4590
234	0.65	280	5040	0.8785	4430
252	0.70	270	4860	0.7920	3850
270	0.75	245	4410	0.6875	3030
288	0.80	170	3060	0.5680	1740

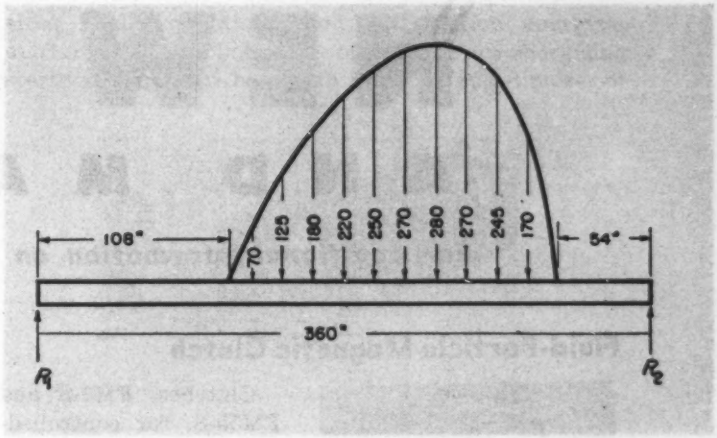


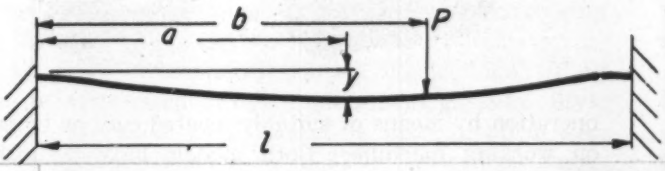
Fig. 2—Distributed load of varying intensity. Numbers denote load intensity in pounds per inch

Summing the values in the final colmn, $\Sigma PK = 32{,}450$. For this beam, $E = 30 \times 10^6$ psi and $I = 1477$ in.^{4}, hence Equation 2 becomes

$$y = \frac{360^3}{48 \times 30 \times 10^6 \times 1477} \times 32{,}450 = 0.712\text{-in.}$$

Similarly, deflections of uniform cantilever beams may be found using TABLE 2, and of beams with built-in ends using TABLE 3.

Table 3—Deflection Factors, K, for Uniform Beams with Built-in Ends



To solve for deflection y substitute in the equation

$$y = K\frac{Pl^3}{192\,EI}$$

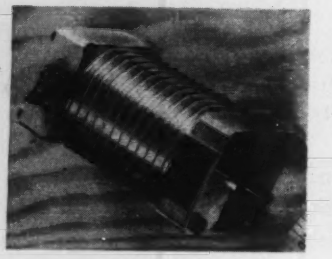
where K is obtained from the table

	Ratio of b/l																		
a/l	.05	.10	.15	.20	.25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95
.05	.0069	.0156	.0223	.0271	.0304	.0321	.0326	.0320	.0304	.0280	.0250	.0216	.0180	.0143	.0106	.0073	.0043	.0020	.0005
.10	.0156	.0467	.0740	.0942	.1080	.1160	.1190	.1175	.1123	.1040	.0933	.0809	.0674	.0536	.0400	.0274	.0164	.0077	.0020
.15	.0223	.0740	.1327	.1797	.2126	.2328	.2418	.2411	.2320	.2160	.1946	.1693	.1416	.1128	.0844	.0579	.0347	.0164	.0043
.20	.0271	.0942	.1797	.2621	.3240	.3638	.3840	.3871	.3756	.3520	.3188	.2785	.2336	.1866	.1400	.0963	.0579	.0274	.0073
.25	.0304	.1080	.2126	.3240	.4219	.4900	.5281	.5400	.5294	.5000	.4556	.4000	.3369	.2700	.2031	.1400	.0844	.0400	.0106
.30	.0321	.1160	.2328	.3638	.4900	.5927	.6571	.6843	.6795	.6480	.5949	.5253	.4445	.3577	.2700	.1866	.1128	.0536	.0143
.35	.0326	.1190	.2418	.3840	.5281	.6571	.7536	.8044	.8123	.7840	.7263	.6460	.5498	.4445	.3369	.2336	.1416	.0674	.0180
.40	.0320	.1175	.2411	.3871	.5400	.6843	.8044	.8847	.9138	.8960	.8398	.7537	.6460	.5253	.4000	.2785	.1693	.0809	.0216
.45	.0304	.1123	.2320	.3756	.5294	.6795	.8123	.9138	.9703	.9720	.9251	.8398	.7263	.5949	.4556	.3188	.1946	.0933	.0250
.50	.0280	.1040	.2160	.3520	.5000	.6480	.7840	.8960	.9720	1.0000	.9720	.8960	.7840	.6480	.5000	.3520	.2160	.1040	.0280
.55	.0250	.0933	.1946	.3188	.4556	.5949	.7263	.8398	.9251	.9720	.9703	.9138	.8123	.6795	.5294	.3756	.2320	.1123	.0304
.60	.0216	.0809	.1693	.2785	.4000	.5253	.6460	.7537	.8398	.8960	.9138	.8847	.8044	.6843	.5400	.3871	.2411	.1175	.0320
.65	.0180	.0674	.1416	.2336	.3369	.4445	.5498	.6460	.7263	.7840	.8123	.8044	.7536	.6571	.5281	.3840	.2418	.1190	.0326
.70	.0143	.0536	.1128	.1866	.2700	.3577	.4445	.5253	.5949	.6480	.6795	.6843	.6571	.5927	.4900	.3638	.2328	.1160	.0321
.75	.0106	.0400	.0844	.1400	.2031	.2700	.3369	.4000	.4556	.5000	.5294	.5400	.5281	.4900	.4219	.3240	.2126	.1080	.0304
.80	.0073	.0274	.0579	.0963	.1400	.1866	.2336	.2785	.3188	.3520	.3756	.3871	.3840	.3638	.3240	.2621	.1797	.0942	.0271
.85	.0043	.0164	.0347	.0579	.0844	.1128	.1416	.1693	.1946	.2160	.2320	.2411	.2418	.2328	.2126	.1797	.1327	.0740	.0223
.90	.0020	.0077	.0164	.0274	.0400	.0536	.0674	.0809	.0933	.1040	.1123	.1175	.1190	.1160	.1080	.0942	.0740	.0467	.0156
.95	.0005	.0020	.0043	.0073	.0106	.0143	.0180	.0216	.0250	.0280	.0304	.0320	.0326	.0321	.0304	.0271	.0223	.0156	.0069

NEW PARTS AND MATERIALS

For additional information on these new developments see Page 163

Fluid-Particle Magnetic Clutch



Clutches, FM5-S and FM55-S, for controlled-torque applications, are designed primarily to provide extremely high acceleration requiring low controlling power such as obtainable from miniature vacuum tubes. Characteristics of the units are: Torque-inertia ratios up to 480,000; essentially proportional output torque with respect to controlling current up to 4500 rpm, providing a high degree of sensitivity for positioning, velocity and rate systems; electrical time constants of from 10 milliseconds for 8 oz-in. of torque to 60 milliseconds for 80 oz-in., with no external resistance; amplification factor of approximately 200, the FM5 controlled by 1 watt can control from 50 to 190 watts of rotational power output; driving efficiency approaching 100 per cent, when the driven load does not exceed the torque capacity of the clutch.

The tendency of iron particles and fluid vehicle to separate due to centrifugal loading at high rotational speeds in these fluid-magnetic units has been overcome by the arrangement of clutch elements. Rotational elements are mounted in double-shielded bearings. Double slip rings are provided so that equipment may be placed in either plate or cathode circuits.

Aside from the single clutches, the manufacturer can provide: Single shaft brake units, FM5-B; twin bidirectional servo means, FM55-T-80; high-speed bidirectional servo, FM5-T-16; twin reversing servo clutches, FM3-TG and FM5-TG. Manufacturer: Duncan & Bayley Inc., 785 Hertel Ave., Buffalo 7, N. Y.

For additional information circle MD 1 on Page 163

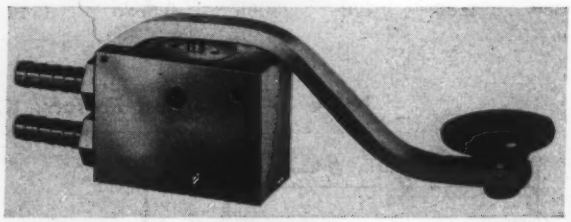
Right-Angle Drive

Utilizing spiral bevel gears that are case hardened, matched and lapped in pairs, RA-2 right-angle drive can be obtained in various capacities ranging from 6 to 12 hp, depending on drive ratio. Stock ratios are 1:1, 2:1, 3:1, 3:2 and 4:3 with other ratios available on special order. Both input and output shafts are 1¼ inches in diameter and are mounted in precision tapered roller bearings. All shaft extensions have dirt and moisture repelling oil seals. Output shaft can extend to right or left, or optional through-shaft provides extensions to both right and left. Manufacturer: Ohio Gear Co., 1338 E. 179th St., Cleveland 10, O.

For additional information circle MD 2 on Page 163

Three-Way Air Valve

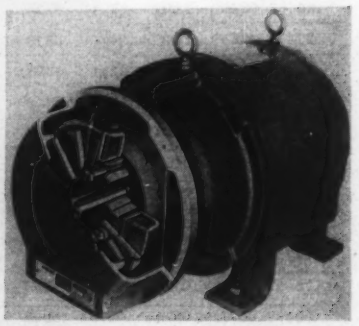
Added to line of fingertip type three-way air valves, these normally-open valves are of poppet type. Model FT-102 valve has ⅜-in. pipe thread apertures for quick response when used with air cylinders up to 6-in. bore, and operates by light touch on handle-lever button. Type FC-102 is same valve without lever, for



operation by means of suitably located cam or trigger on working machine. Both models have mounting holes at top and sides to facilitate attachment to any machine. Hose nipples to take ⅜-in. OD air hose are included. Manufacturer: Mead Specialties Co., Dept. V-25, 4114 N. Knox Ave., Chicago 41, Ill.

For additional information circle MD 3 on Page 163

Disk-Type Electric Brake



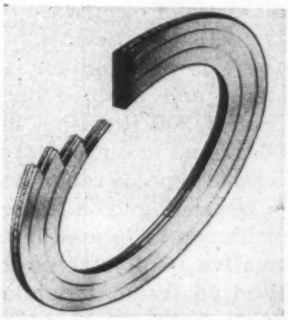
Utilizing not only friction but also power of electromagnetic attraction between its ring-shaped electromagnet and armature disk, this electrically operated brake gives easily-controlled smooth-cushioned stops to electric motors. Unit requires only 25 to 35 watts d-c for full application. Because applied power varies with flow of current through magnet,

brake action can be controlled manually or automatically to as fine a degree as machine-operating cycles require. Steel plate back of armature disk acts as blower to dissipate heat as generated.

Brake offers self-adjustment, since armature disk rides in constant light contact with friction surface of electromagnet. Where application requires, light spring pressure maintains this constant contact and follows up all wear between two surfaces to minimize need for mechanical attention. Unit mounts to standard NEMA C flange. Standard production sizes are available for mounting on NEMA standard motor frame sizes 203 through 365. Larger and smaller brakes also are available for special motor mountings. Rectified power can be obtained from 110, 220 or 440-volt a-c by using simple conversion unit. Manufacturer: Warner Electric Brake Co., Beloit, Wisc.

For additional information circle MD 4 on Page 163

Flexible All-Metal Gasket



Made of several types of ferrous and nonferrous metals in combination, this spiral-wound flexible all-metal gasket is suited for applications where high temperature and pressure and permeability of confined materials limit use of soft fillers. It does not take permanent set and will not contaminate confined liquids.

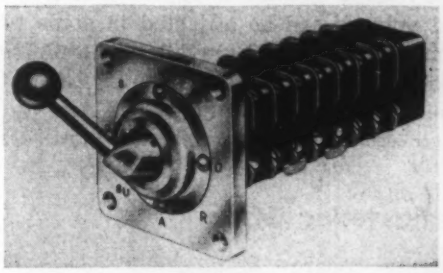
Style CGI compression gage gasket for high temperature and pressure service incorporates inside ring to minimize high friction factors and eliminate turbulence by streamlining jointed connections. Ring can be remounted in new replacement gaskets. Style CG compression gage gasket is now supplied with rings having thickness of 3/32-in. as well as standard thicknesses. This size was designed to meet varying conditions of flange face finish.

Basic thickness of 0.125-in. is now employed for entire gasket line, in addition to former standard thicknesses of 0.175 and 0.285-in. Each thickness is subject to varied yield characteristics for both marine and industrial applications. Manufacturer: Flexitallic Gasket Co., Eighth & Bailey Sts., Camden 2, N. J.

For additional information circle MD 5 on Page 163

Rotary Selector Switch

Designed and assembled to meet exact requirements of specific applications, Arrow-Hart push-pull selector switches provide single master switch controls which centralize multiple operations at one point. Eight to 16 positions can be set up on single dial, and three-wire control provides under-voltage operating protection. Visible indications on switch face plate and position of handle enable operator to check operation last selected or move to next desired position. Pulling on handle in selected position starts desired function; pushing handle stops the action. Push motion drops out starters before load connections can be changed. Turning establishes desired load connections, and pull motion energizes starters. To establish load contacts before energizing starters, cams can be cut to delay or speed close, or



to hold on contact between position of rotation. Cam sections are rated at 30 or 60 amp per circuit and are built in multiple sections to individual specifications as to control and load circuit combinations. Manufacturer: Arrow-Hart & Hegeman Electric Co., Industrial Control Div., 103 Hawthorn St., Hartford 6, Conn.

For additional information circle MD 6 on Page 163

Centrifugally Cast Bearing

Centrifugal casting of these bronze bushings results in production of dense, fine-grained material which is free from porosity, blow holes, sand inclusions and pits. They are made on order to required size in any common bearing alloy. Bearings have fine surface finish and are suitable for severe service requirements. Typical applications are in diesel, aircraft and stationary engines; airframes, road machinery, sheaves, crane wheels and other heavy-duty uses. Manufacturer: Induction Processing Co., 3321 W. Fifth St., Tulsa, Okla.

For additional information circle MD 7 on Page 163

Variable Speed Drive

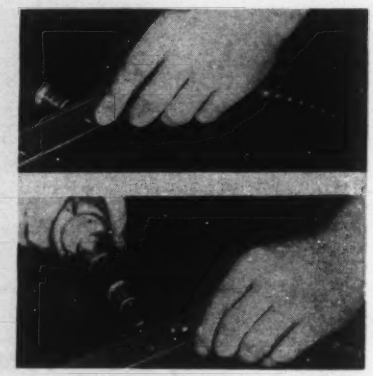
Multiple speed operation of ⅓-hp, d-c shunt motor from a-c line is possible through use of type 1700-A Variac speed control. Constant field voltage is supplied by dry-disk rectifier, while armature voltage can be varied by Variac autotransformer feeding electronic rectifier. Smooth regulation is obtained from rated speed of motor down to practically zero. Regulation in revolutions per minute is constant at all speed settings and is adequate for the great majority of applications.

Low ripple current in armature circuit minimizes motor losses and allows motor to operate at full direct current rating. Overload capacity for starting

is several times full-load armature current, and full protection is provided by circuit breaker. Single box houses both control and manual start-stop-reverse switch. Dynamic braking is provided in stop position, and field voltage can be adjusted in steps to change maximum speed. Drive is available in 115 and 230-volt models. Manufacturer General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

For additional information circle MD 8 on Page 163

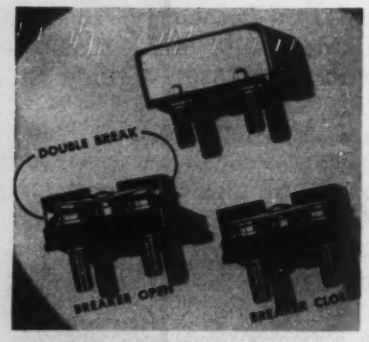
Metal Fastener Strip



Permitting operator to break strip from leading fastener with clean separation as it is tightened, Tandem-type flat Speed Nut consists of strip of pretempered steel into which fasteners are stamped with partial shear separating each unit. Produced in either strips or coils, they are available at present for size 10-24 screws only. Manufacturer: Tinnerman Products Inc., 2044 Fulton Rd., Cleveland 13, O.

For additional information circle MD 9 on Page 163

Low-Voltage D-C Circuit Breakers

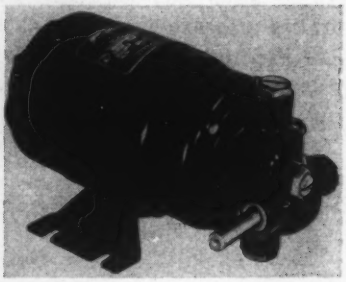


Designed for use in low-voltage d-c circuits on transportation equipment and in many other special circuit applications, Klixon C9121 circuit breakers are available in ratings of 8, 10, 15, 20, 25 and 30 amp. Small compact unit utilizes Klixon thermal disk which assures clean snap-action making and breaking and vibrationless operation. Stud terminals are molded into phenolic base, and metal cover totally encloses disks and contacts. Utilizing double-break contact action, standard unit can be used on all 6 and 12-volt d-c applications and in many 24-volt circuits.

Inherent time lag characteristics avoid nuisance trip-outs by harmless transient shorts and, at same time, permit operation of equipment to maximum safe limits with complete safety. In operation, snap disk opens contact at predetermined overloads, breaking circuit. After short cooling period, disk automatically closes and re-establishes circuit. If overload condition persists, breaker reopens and cycles automatically. All types are calibrated to carry at least 100 per cent of nominal rating continuously and to trip ultimately at not more than 125 per cent of nominal rating when in ambient of 77 F. Manufacturer: Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.

For additional information circle MD 10 on Page 163

Gearhead-Reduction Motor



Basically a standard motor with self-contained gear reduction mechanism, gearhead motor is obtainable in complete range of countershaft speeds for powering all types of electrically actuated devices. Drive is supplied for single and double-reduction requirements in ratings from 1/200 to ⅓-hp, in reduction ratio from 6:1 to 900:1 and in output torque from 1 to 500 lb-in. Countershaft speeds range from 833 to 8 rpm.

Depending upon motor frame size employed, countershaft can be located in increments of 30 or 90 degrees relative to horizontal center line by relocating gearhead on frame. Induction-hardened alloy steel worms and bakelite or bronze gears provide high reductions in small space and permit quiet operation. Generally, gearhead unit has same characteristics as its power source. Motors are supplied for special and general duty requirements in all basic motor types. Manufacturer: Robbins & Myers Inc., Springfield, O.

For additional information circle MD 11 on Page 163

Midget Disk Type Thermostat

This compact, quick make and break type M thermostat is usable for close temperature control of electronic devices, appliances and industrial apparatus. Control results from electrical independence of disk-type bimetal thermal element. Built with variety of terminal arrangements, unit operates on small differentials in range of from −60 to 600 F. Standard closure type for normal operation and hermetically sealed type for special applications are available. Manufacturer: Stevens Mfg. Co. Inc., Mansfield, O.

For additional information circle MD 12 on Page 163

Unit Type Pillow Block

Capable of holding shafts revolving at high speeds, this pillow block can be obtained with either ball or spherical roller bearings. The unit is designed with

tapered inner ring and tapered split compression sleeve which grips the shaft upon tightening of the lock nut. Concentric grip will not loosen even though shaft may vibrate, and use of sleeve eliminates need for lock screws. Unit pillow block is completely assembled and prelubricated for immediate installation. It is equipped with floating seals to prevent leakage and entrance of dirt and other foreign matter. Blocks are recommended for use on mine hoists, dredge pumps, fans, marine propellers, lift trucks and conveyors. Shaft sizes in "free" or "held" types range from 1-7/16 to 2-7/16 in. Manufacturer: SKF Industries Inc., Philadelphia, Pa.

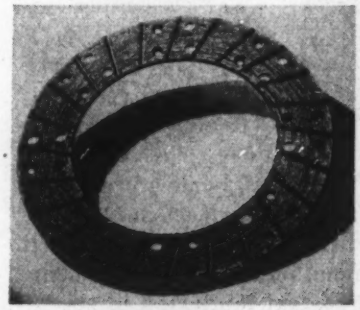
For additional information circle MD 13 on Page 163

Bonding Agent

Meeting industrial requirements for pressure, chemical and temperature resistance, bonding agent R-313 metallurgical product permits easy manual bonding of similar and dissimilar materials such as glass, plastics, neoprene and leather goods to metals, and ferrous to nonferrous metals. Manufacturer: Western Sealant Inc., 9042 Culver Blvd., Culver City, Calif.

For additional information circle MD 14 on Page 163

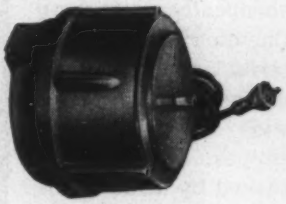
Asbestos-Metallic Clutch Facing



Specific clutch action of any clutch design can be matched by S-W spiral wound facing of asbestos-metallic yarns. Material is flexible for ease of handling during installations, and has low torque variation under wide range of temperature and load conditions with minimum chatter in all engagements. Winding of asbestos-metallic yarn is close and uniform, and edges are smooth. Manufacturer: Johns-Manville, 22 E. 40th St., New York 16, N. Y.

For additional information circle MD 15 on Page 163

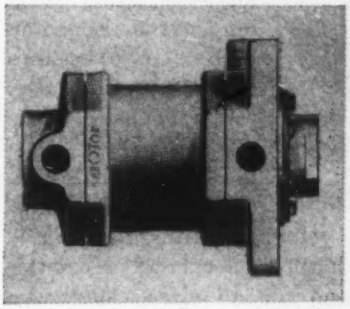
Submersible Pump Motor



Housed in hermetically sealed castings En-Po motor can be used wherever exposure to excessive dust, dirt, moisture or total submersion is involved. Typical applications are for pumps, dairy equipment, food machinery, machine tools, chemical and pharmaceutical equipment, outdoor machinery and displays, shipyards and elevators. Motor can be supplied with three-phase, split-phase or capacitor windings for all standard voltages and frequencies in ⅛ to ⅓-hp ratings. Flange mounting with rabbets machined to close tolerances is standard, but special mountings and windings can be supplied to meet specific requirements. Manufacturer: Piqua Machine & Mfg. Co., Piqua, O.

For additional information circle MD 16 on Page 163

Hydraulic Cylinder Cushion Plate

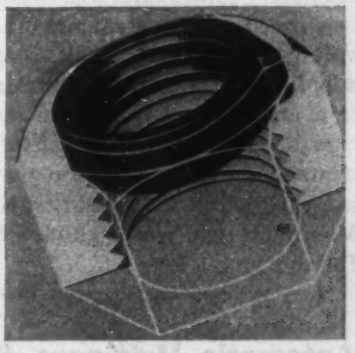


Having 150-psi air and 300-psi oil pressure capacities, series 100 cylinders are improved by addition of cushion units. Cushion plate attached to cylinder cover blocks off flow of exhaust air or fluid when cushion bushing attached to piston rod enters this mating cushion plate. Air or fluid displaced by movement of piston is thus compressed and metered out through adjustable needle valves, thereby cushioning piston during remainder of stroke. One needle valve, located in blind end cover, controls speed of cushioning stroke when piston rod is retracting. Other needle valve, located in rod end cover, controls speed of cushioning stroke when piston rod is extending. Two check valves built into cushion plates permit unrestricted flow of pressure into cylinder.

Cylinders are supplied with cushioning on both ends of cylinder or on either end. Bore sizes in which cushioning strokes can be obtained are 1½, 2, 2½, 3, 4½, 6, 8, 10, and 12 in. Each size is available in rabbet, foot, trunnion, center line, blind end flange, rod end flange and clevis mountings. Manufacturer: Gerotor May Corp., Baltimore 3, Md.

For additional information circle MD 17 on Page 163

Heavy-Duty Self-Locking Nuts

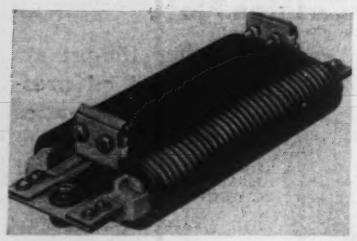


Resistant to loosening as result of vibration on many types of heavy-duty industrial equipment, Security locknuts are a combination of standard nuts and specially designed retainers fabricated into permanent units. When locknut is applied, bolt forces slightly elliptical heat treated alloy steel retainer back into round and causes it to grip bolt securely. Bolt load or stress is borne entirely by nut since retainer becomes isolated automatically from bearing contact with nut and functions solely as lock to prevent turning. Lock-

nuts are made with National Coarse and National Fine threads in standard sizes from ⅜ to 2½ in. Manufacturer: Security Locknut Corp., 1815 N. Long Ave., Chicago 39, Ill.

For additional information circle MD 18 on Page 163

Continuous-Duty High-Current Resistor



Obtainable in 6, 9¼, 12¼, and 15¾-in. lengths, Edgeohm high current resistors employ continuous noncorrosive oval-shaped alloy resistance ribbon with clamp-type terminals. These four sizes have minimum resistance value per unit of 0.5 ohms. Continuous current capacities range from 21 to 79 amp for all sizes. Maximum continuous duty ratings are approximately 2200 w for 19-in. units to 320 w for 6-in. resistors.

Units can be furnished with individual stamped steel mounting brackets or with multiple units up to four mounted in single open frame. Additional clamp terminals and special multiunits or enclosed assemblies can also be obtained. Intermittent duty applications include starting, dynamic braking, field discharging and plugging on motor controllers. Typical continuous duty applications include load banking, battery charging and welding and plating rheostats. Manufacturer: Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.

For additional information circle MD 19 on Page 163

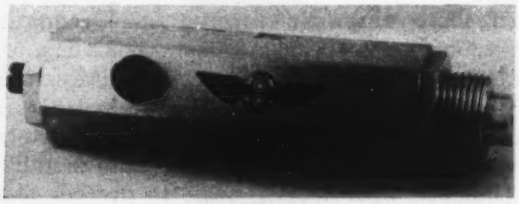
Adjustable Speed Drive

Using armature control to make possible speed range of 20 to 1 at constant torque, Mot-O-Trol fractional-horsepower electronic adjustable-speed drive starts, stops and controls speeds of ⅛ to ½-hp, d-c motors and operates from single-phase 50/60-cycle 220/440-v power sources. Drive provides smooth stepless speed control, dynamic braking, overload and low-voltage protection. Small, compact control station is supplied for separate mounting at convenient location and is used to control starting, stopping, direction of rotation, and speed of motor. Other components, used to rectify a-c power for the d-c motor, are enclosed in wall-mounted NEMA Type 1 enclosure. Manufacturer: Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa.

For additional information circle MD 20 on Page 163

Automatic Multigage Cutout

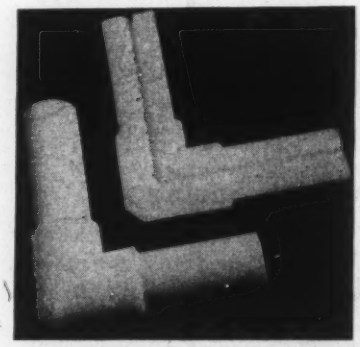
Designed as automatic device to protect all gages in multigage pressure systems, model DV15-200 gage cutout eliminates manually cutting down each gage in system when that unit is not in use. It can be installed in any gage line to provide protection for



gage by automatically cutting it out of circuit if line pressure should suddenly rise above safe operating range. Positive opening and closing action of cutout eliminates need for relief valve and shut-off valve. Device can be obtained in series ranging from 30 to 300 psi and from 400 to 3000 psi. Manufacturer: Greer Hydraulics Inc., 454 Eighteenth St., Brooklyn 15, N. Y.

For additional information circle MD 21 on Page 163

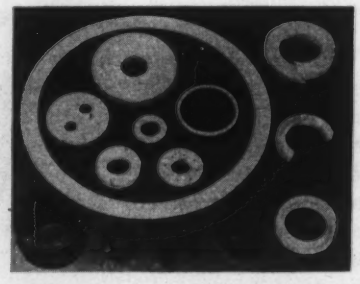
Light-Weight Cold Pipe Insulation



Especially suited for cold pipe insulation, K-Shield lightweight pipe and vessel insulation is made of Styrofoam expanded plastic containing minute closed-wall cells. Weighing approximately 1½ lb per cu ft, the material is rigid yet highly workable and can be cut and fitted with ordinary tools. No vapor seal coating is necessary as it has high moisture, vapor and mold resistance. Material has been successfully used on pipe lines where temperatures range from −250 to 175 F. It is manufactured for all standard pipes and fittings and is custom fabricated to specifications for insulating processing equipment and other nonstandard items. Manufacturer: Robinson Industries, Coleman, Mich.

For additional information circle MD 22 on Page 163

Molded Packing Material

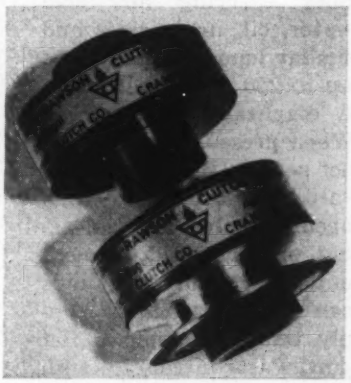


Effective to temperatures of 450 F, chemically - inert Chemlon packing material is supplied in molded form in a wide variety of shapes. It is not attacked by acids or alkalies and stands up for long periods under difficult sealing conditions. Flexibility of material facilitates installation of packing rings. Combination of low power factor and high dielectric constant allows use as insulator for high frequency trans-

mission lines where low loss is necessity. Among molded forms now furnished are washers, bushings, rings, self-sealing V-cross-section rings, ring gaskets and jacketed gaskets. Manufacturer: Crane Packing Co., 1800 Cuyler Ave., Chicago 13, Ill.

For additional information circle MD 23 on Page 163

Centrifugal Clutch Coupling

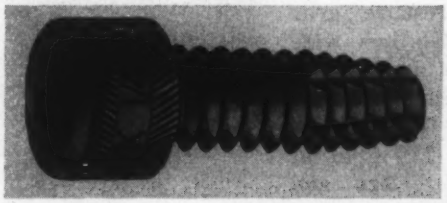


Designed to permit preselection of point at which motor or engine engages load, this Rawson centrifugal clutch coupling has wide range of drive characteristics. It can be preset for use on fractional and low unit horsepower units by adjusting friction segments and springs. Also available are pulley type clutches with standard sizes of pulleys. Each unit is individually packaged and furnished with complete instructions for application and adjustment. Manufacturer: Centric Clutch Co., Cranford, N. J.

For additional information circle MD 24 on Page 163

Self-Tapping Cap Screw

Usable for many applications which do not require exceedingly high stress concentrations, this fastener is a combination of size-marked socket head of standard P-K capscrew and thread body of type F self-tapping screw. These fasteners cut threads in plain drilled holes in metals or plastics. This screw can



be removed readily and replaced in same hole any number of times without materially reducing its holding power. It is particularly suitable for fastening many parts which must be removed for servicing. Manufacturer Parker-Kalon Corp., 200 Varick St., New York 14, N. Y.

For additional information circle MD 25 on Page 163

High-Temperature Hydraulic Fluid

Recommended for use in diecasting and for hydraulically operated installations such as welding machines and coal mining equipment, Lindol HF-X is flame-resistant tricresyl phosphate base hydraulic fluid. It does not give off noxious fumes when exposed to high temperatures and has high lubricity and good corrosion resistance. Fluid can be obtained in wide range of viscosities and can be used in any system equipped for nonhazardous hydraulic fluid operation. Manufacturer: Celanese Corp. of America, 180 Madison Ave., New York 16, N. Y.

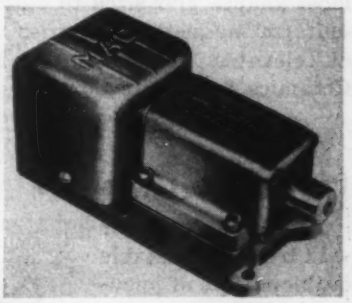
For additional information circle MD 26 on Page 163

Industrial Wheel

Supplied in 6, 8 and 12-in. sizes, Alcore industrial wheels are strong yet light in weight. They feature smooth aluminum core, highly resilient rubber-compound tread and cage type roller bearings. Special sizes and tread compounds, are available on quantity orders. Manufacturer: Bassick Co., Bridgeport 2, Conn.

For additional information circle MD 27 on Page 163

Solenoid Pneumatic Valve



Since two inlet ports of Mac solenoid-operated air valve allow full line pressure to be applied to work stroke of air cylinder and much lower pressure to be applied to return stroke, savings in compressed air are effected. High or low pressure can be applied to either inlet port. Pressure range, 20 to 150 psi; pipe sizes, ⅜ and ¾-in.

Assembly consists of iron base, bronze body with retainers, solenoid with cover, and chromed-aluminum piston which is the only moving part. O-ring type seals give "sealed with air pressure" feature of poppet type valve and yet maintain ease of operation of direct solenoid balanced type. Manufacturer: Mechanical Air Controls Inc., 3049 E. Grand Blvd., Detroit 2, Mich.

For additional information circle MD 28 on Page 163

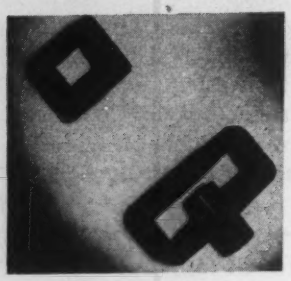
Ratchet Type Counting Device

This Duo-Cam counter can be supplied both as revolution ratchet counter, adding one count for each revolution of drive shaft in either direction, and as ratchet with stops counter which adds one count for each oscillation of lever through angle of 30 degrees. Latter type is made to order only. Maximum recommended speed

of revolution ratchet type is 200 counts per minute and of other style, 500 counts per minute. Shaft is at right side, with top coming or going. Unit is reset by clock key. It is designed chiefly for such applications as size-grinding operations and counting number of pieces graded. Manufacturer: Veeder-Root Inc., Hartford 2, Conn.

For additional information circle MD 29 on Page 163

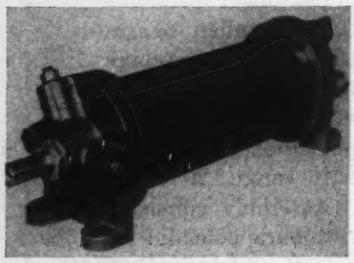
Nonmetallic Magnet



Similar to ceramics as they are of uniform structure and contain no organic compounds, Ferramic nonmetallic materials have magnetic properties and are adaptable for use where space and weight are factors. Suitable for all core applications, materials can be mass-produced in most shapes and sizes to close tolerances. They have uniform magnetic properties and will not decompose at elevated temperatures. Manufacturer: General Ceramics & Steatite Corp., Keasby, N. J.

For additional information circle MD 30 on Page 163

Pneumatic Cylinders



Available with or without adjustable cushions, line of pneumatic cylinders in 80 to 100-psi pressure range is offered in seven different styles up to 8-in. bore. To join cylinder head to body, round spring-steel wire snap rings seated in rounded grooves in cylinder body and steel clamping collars are used instead of tie rods. Clamping collars hold snap rings firmly against bottoms of grooves in cylinder body. Standard heat-treated steel socket-head cap screws attach clamping collars to cylinder heads. Design reduces longitudinal column stresses and facilitates cleaning of external surfaces of cylinder. Manufacturer: Tompkins-Johnson Co., Jackson, Mich.

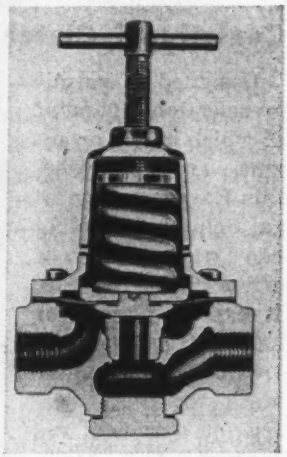
For additional information circle MD 31 on Page 163

Colored Plastic Coating

Available in white, machine gray and crystal clear, Krylon No. 200 series of protective plastic coatings can be applied by spraying, dipping or brushing. Surface is resistant to abrasion and fading or discoloration from sunlight or fumes. Containing high solid content, coating bonds to both metal and wood and requires only air drying. Clear coating has no tendency to cloud when applied in humid weather, and leaves no orange peel effect. Special thinner for this series is also supplied. Manufacturer: Foster & Kester, Philadelphia 32, Pa.

For additional information circle MD 32 on Page 163

High-Volume Diaphragm Valve



High volume relief without blow-down is afforded lines carrying air, cold water, oil, insecticides and similar liquids at pressures up to 250 psi by series 62-A diaphragm relief valve. When pressure exceeds relief setting, diaphragm and valve seat are raised, thus opening valve and releasing air or liquid through outlet port. Surplus liquids can be discharged to supply tank by piping outlet port. Parts in contact with fluid handled are brass, and synthetic rubber diaphragm which is reinforced with nylon cloth is highly resistant to fluids for which valve is recommended. Regulating springs are available in six sizes for relief pressure ranges of from 2-15 psi to 5-125 psi, and valves are obtainable in from ⅛ to 1-inch pipe sizes. Manufacturer: C. A. Norgren Co., 222 Santa Fe Drive, Denver 9, Colo.

For additional information circle MD 33 on Page 163

Gear-Type Hydraulic Pump

Primarily designed for automotive quick oil-changing equipment, model 1304 positive-pressure gear pump also has wide range of applications in hydraulic and fluid transfer field. Unit delivers 1½ gpm at 200 psi. Size and weight are minimized and alignment assured by close coupling with ¼-hp 1725-rpm G-E motor. Pump is equipped with aluminum body, bronze gears and cup seal. Manufacturer: Eastern Industries Inc., 296 Elm St., New Haven 6, Conn.

For additional information circle MD 34 on Page 163

A-C Induction Motor

Ranging from 20 to 75 hp, Life-Line a-c induction motors are produced in squirrel-cage and wound-rotor types. Supplied in all standard ratings at 60, 50 and 25 cycles, they are both dripproof and splashproof. Stator frame is heavy-rolled steel, permitting motor

JOHNSON BRONZE
SLEEVE BEARING DATA
Bearing DESIGN
SLEEVE BEARING DATA

Standard Tests for Sleeve Bearings-1

IN the selection of the proper type of Sleeve Bearing for any given application there are certain fundamental steps to follow before arriving at the final decision. The first move is to determine, as near as possible, the operating requirements such as speeds, loads, shock, temperature, lubrication, etc. The next step is to compare, by certain known and accepted tests, which bearing *material* will meet these requirements in the most satisfactory manner. Samples of the various materials, each produced to the same size and thickness are then used so that each test is comparative. Thus by matching the operating requirements of the application to the physical properties of the bearing material we arrive at a satisfactory selection of the proper bearing to use.

In determining the physical properties of bearing materials we use the following tests:

Johnson Bronze Alloy No.	PHYSICAL PROPERTIES				
	Tensile lb. per sq. in. ±5000	Proportional Limit ±2000	Yield Point lb. per sq. in. ±3000	Elongation per cent in 2 in.	Brinell Hardness No.
19	27,500	7,800	20,700	8±4	62
25	22,500	6,900	16,750	11±4	44
27	30,000	9,700	19,000	10±5	58
29	24,000	7,600	16,400	9±4	52
51	36,500	12,500	18,500	15±5	67
53	36,000	13,000	19,000	18±4	69
55	39,200	13,600	21,000	10±5	74
66	26,000	7,800	14,500	12±5	48
71	29,000	8,200	16,500	20±7	49
72	29,000	8,600	14,600	17±5	56

A typical listing and comparison of various popular, cast bronze bearing alloys.

Tensile Strength

The ultimate tensile strength is the maximum load per square inch the material will carry up to the point of rupture. It is really a test of toughness.

Yield Point

The yield point is the load in pounds per square inch necessary to produce an elongation of .2% of the original specified length.

Elongation

This property is expressed as the percentage of length increase, after test piece has been ruptured, divided by the original specified length. This test is an indication of the material's conformability property and in addition indicates to a certain degree the shock resisting capacity of the material.

Reduction of Area

This property is determined by measuring the decrease which occurs in the cross sectional area of the specimen at the point of rupture, as compared to the original diameter of the test piece. This property is also expressed as a percentage.

Hardness

Hardness can be determined in several ways, with the Brinell and the Rockwell methods being the most popular in non-ferrous materials. In determining the Brinell hardness number we use a 10 millimeter ball and apply a 500 kilogram load for a period of thirty seconds. Hardness is, in fact, an indication of the material's resistance to deformation, which also indicates the compressive strength of the material.

Compressive Strength

This test establishes the percent of permanent deformation occurring under specified loads. It is figured in relation to the size and form of the specimen used for testing.

●

Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

●

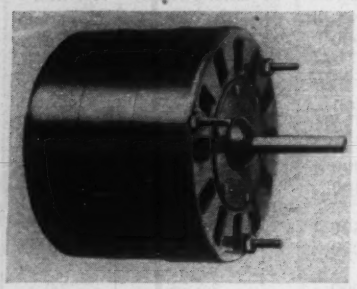
This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze
SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

to be wall or ceiling-mounted with equal protection. Brackets are dripproof, with top half solid and ventilating openings on lower half only. Both sleeve and ball bearing brackets are available. Sleeve bearing motors are sealed-sleeve type with air by-pass, and ball bearing motors use self-sealed prelubricated bearings. Manufacturer: Westinghouse Electric Corp., Buffalo, N. Y.

For additional information circle MD 35 on Page 163

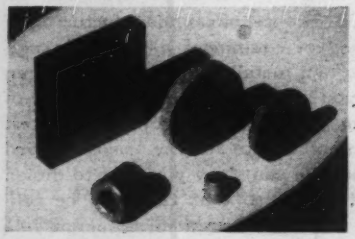
Fractional-Horsepower Six-Pole Motor



Obtainable with 5-in. OD and in two lengths, six-pole shaded-pole fractional horsepower motor operates at speeds from 1000 to 1050 rpm with ratings from ⅛ to 1/30 hp. Further speed reductions down to 500 rpm are possible by use of choke control coils. With ⅜-in. diameter shaft extension furnished, motor is available for either stud mounting from end cases or resilient base mounting. Either open or enclosed housings can be supplied to meet rating and ventilation requirements, and designs are available for horizontal or vertical operation. Manufacturer: Fasco Industries Inc., Rochester 2, N. Y.

For additional information circle MD 36 on Page 163

Stainless Steel Filter



Recommended for filtering, separating, diffusing and regulating flow of wide variety of liquids and gases, these stainless steel Oilite units are also useful for handling corrosive materials and for applications where contamination must be avoided. Typical shapes include disks, sheets, plain cylinders and cones; special shapes are available on order. Made from stainless steel powders, units provide depth filtration and enable porosity or permeability to be closely controlled between 0 and 60 per cent. Filters can be flushed easily and are not brittle or friable. Manufacturer: Amplex Mfg. Co., Detroit 31, Mich.

For additional information circle MD 37 on Page 163

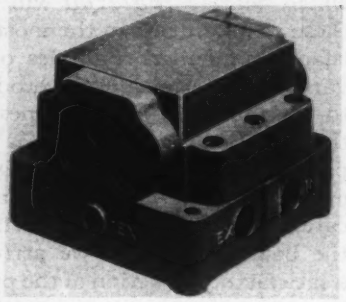
Vibration Mount

Employing 'rubber-in-shear' principle, Finnflex CM-H vibration mount is intended for use with precision grinders, lathes, generators, pumps, compressors, jig borers and other installations where horizontal and

rotary machinery vibrations are present. It consists of steel channel floated in rubber between two steel angles. Correct angularity between steel parts and rubber bonded to them enables isolator to approximate 'flat' spot on stress-strain curve of relative slope. Because spring index is not constant, resonance is avoided. Overall height of unit is only 2 in. Load range is from 600 to 10,000 lb. Manufacturer: Finn & Co., 2850 Eighth Ave., New York 30.

For additional information circle MD 38 on Page 163

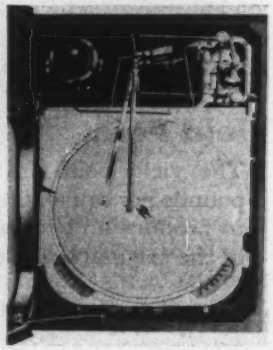
Master Air Control Valve



Controlled by one 4-way or two 3-way pilot valves, this 4-way Mastair valve is a balanced-spool type. Use of straight-line piping minimizes need for fittings. Valve mechanism is accessible without disconnecting piping, and parts are interchangeable in any size unit. Standard sizes are ⅜, ½, ¾ and 1-inch. Cam, lever, pushbutton and foot-operated control pilot valves are available. Manufacturer: Hanna Engineering Works, 1765 Elston Ave., Chicago 22, Ill.

For additional information circle MD 39 on Page 163

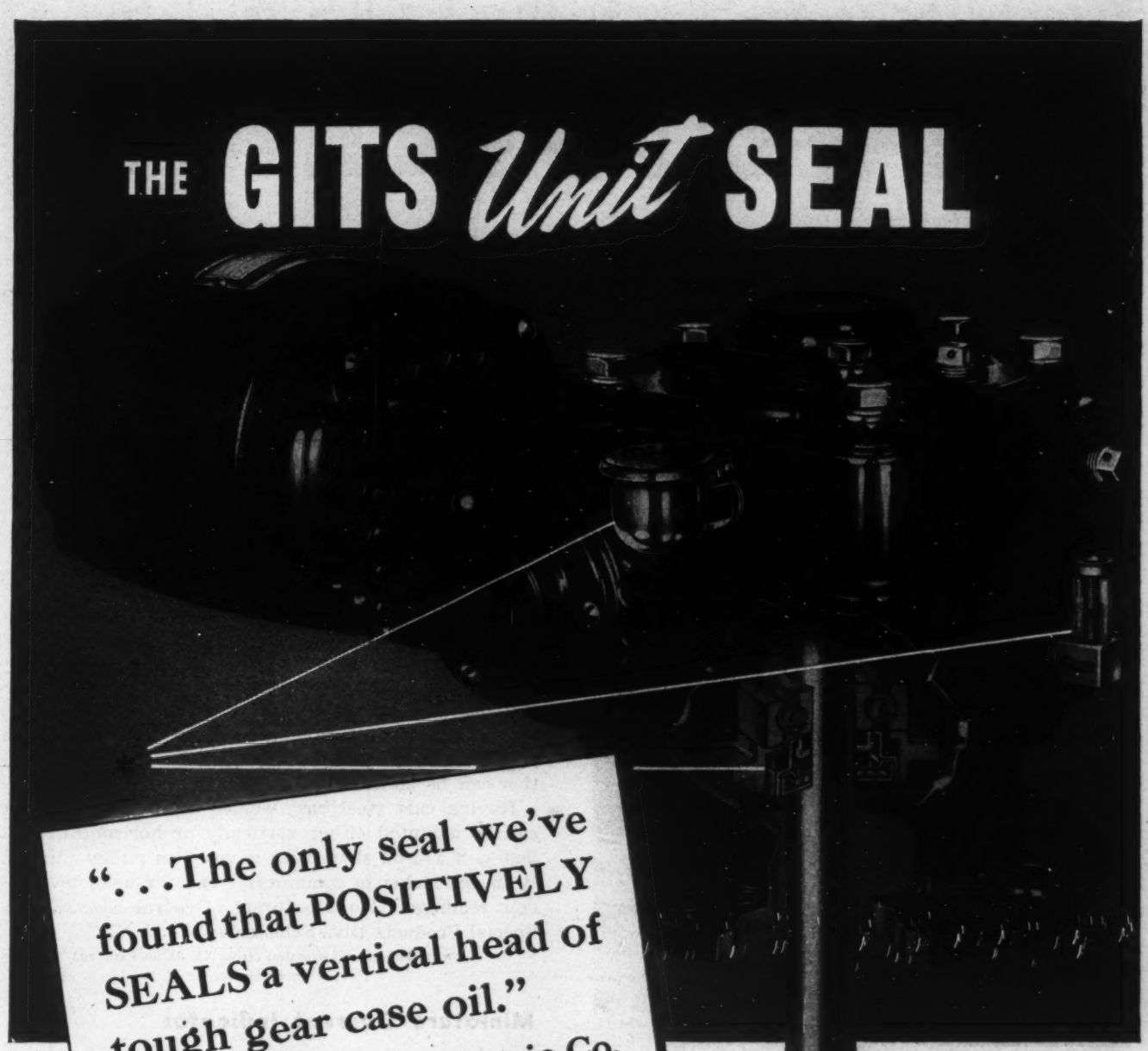
Air-Operated Control Instruments



Included in series 500 line of air-operated controllers are instruments for automatically regulating temperature, pressure, flow, liquid level, humidity and pH value. Reset rate, derivative time and proportional band adjustments are accurately calibrated and reproducible. Instruments have only one service adjustment and are equipped with reset action stops. Controllers can be completely disassembled and after being reassembled with replacement parts, only one adjustment is required to put the system in exact calibration. They are supplied in five types of control action: on-off, proportional reset, derivative and reset plus derivative. They are readily convertible from one type to another. Manufacturer: Bristol Co., Waterbury, Conn.

For additional information circle MD 40 on Page 163

THE GITS *Unit* SEAL



"...The only seal we've found that POSITIVELY SEALS a vertical head of tough gear case oil."

... Bodine Electric Co.

That's why Bodine Electric Company engineers chose the Gits Unit Seal for the Bodine "Group 4" worm gear reducer (shown here). Gits engineers then *applied* the Unit Seal without causing any redesign of the reducer.

Gits Seals can solve *your* shaft sealing problems, too —effectively and economically. Send us your shaft sealing problems on *any* type of equipment, for prompt recommendations (no obligation).

Write Today

for informative, detailed booklet on the Gits line of shaft seals—complete with diagrams and illustrations of various applications.

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* Note the Gits "Style FG" Oil Gauge and the Gits "Style KV" Oil Cup. Gits oils it, seals it, gauges it!

ENGINEERING DEPARTMENT

EQUIPMENT

For additional information on this new equipment see Page 163

Drafting Machine

Functions of T-square, straight edge, triangles, protractors and scales are combined in this redesigned drafting machine. Among improvements are redesigned base line clamp located for greater convenience in aligning drafter to drawing, ball joints on both arms, increased space between double thumb screws which fastens machine to board to provide improved anchorage, and Equipoise mechanism. The mechanism counteracts effect of gravity when draftsman is working on tilted drawing board. Drafter cannot drift down board, and there is no tendency to kick back. Draftsman can align drafter scales quick-

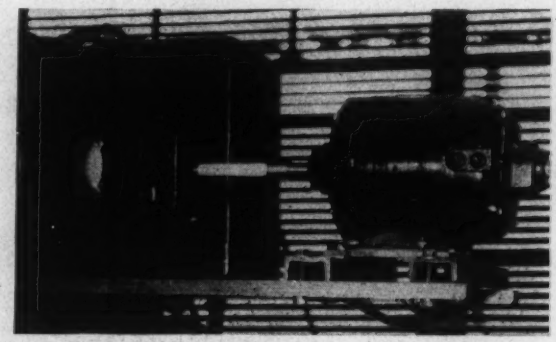
ly and accurately to any part of drawing. Fluted adjustment knob on mechanism sets correct tension for angles between 0 and 20 degrees from horizontal.

Slight thumb pressure on touch control button allows drafter head to be rotated to any of 24 commonly used angles. Releasing button automatically locks head at desired angle. When head is disengaged, it can be locked at any intermediate angle with head brake. Manufacturer: Charles Bruning Co., 4754 Montrose Ave., Chicago 41, Ill.

For additional information circle MD 41 on Page 163

Tachometer Generator

Available in three models with speed ranges of 100 to 1450, 100 to 2500 and 100 to 5000 rpm, this heavy duty d-c tachometer generator is accurate within 0.3 per cent of full scale with portable instrument, and within 1 per cent of full scale with other indicating instruments. Generator is totally enclosed and features rubber-mounted ball bearings and Alnico permanent magnet field. End play is preloaded to 100



lb to counteract end thrust of large machines to which unit is mounted.

Output voltage of generator is directly proportional to speed. Sufficient power is produced for control purposes and operation of an instrument simultaneously or operation of several instruments in parallel. Unit operates in either direction and rotation can be indicated by zero-center instrument.

Having cast steel base welded to frame, generator can be mounted either vertically or horizontally. It has $\frac{5}{8}$ x $1\frac{7}{8}$-in. shaft with keyway on pulley end and $\frac{1}{8}$-in. extension to commutator end for hand tachometer readings. Manufacturer: General Electric Co., Special Products Div., Schenectady 5, N. Y.

For additional information circle MD 42 on Page 163

Miniature Current Indicator

Designed to measure load current of various electrical devices operated on alternating current, Mini-Amp miniature current indicator has accuracy within 5 per cent of actual load. Instrument measures about 2 x 2 x 1 in. and has opening in center through which is passed current-carrying conductor. The range of the meter may be changed by increasing the number of turns of wire passed through the opening. Available in different ampere ratings, this device will withstand rough usage. Neon indicator, which glows at minimum amperage flow, is guaranteed for service life of at least 25,000 hr. Manufacturer: Industrial Devices Inc., Edgewater, N. J.

For additional information circle MD 43 on Page 163

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HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

72. Shims, Lock Nuts & Stampings

Laminated Shim Co.—8-page illustrated data file "Shims, Lock Nuts, Stampings" deals with Laminum shims which peel for gage adjustment; An-cor-lox lock nuts which use nonspringing metal ring at base of nut for locking device; and small flat stampings which can be furnished in brass, steel, aluminum, copper and plastic.

73. Commercial Glasses

Corning Glass Works—16-page illustrated form No. B-83 lists properties of selected commercial glasses which include Pyrex, Corning and Vycor. Thermal stresses, heat transmission, electrical properties, corrosion resistance and viscosity data are given also.

74. Extruded Aluminum Shapes

Reynolds Metals Co.—4-page illustrated bulletin "Reynolds Lifetime Aluminum Extruded Shapes" explains how aluminum can be produced in almost any cross-sectional shape. Commercial tolerances, extrusion method, design possibilities, mechanical properties, chemical composition and other data are included.

75. Production Machining

Carey Machine Co.—4-page illustrated catalog "Fast—Accurate Production Machining" describes facilities for producing wide variety of parts, including precision finishing and complete assembly. Production operations are illustrated and types of machine tools listed.

76. Worm Gear Speed Reducers

D. O. James Gear Mfg. Co.—24-page illustrated catalog No. 40-S contains engineering data and prices of single and double worm gear speed reducers. First type is available in 24 sizes with ratio ranges of 5.66:1 to 100:1, and double type is obtainable in 10 sizes with ratio ranges of 87:1 to 10,000:1.

77. Testing Machine Devices

Baldwin Locomotive Works, Eddystone Div.—12-page illustrated bulletin No. 261-A depicts and describes supplementary devices for adapting testing machines to widest scope of testing conditions. These include equipment to hold specimens, widen testing range and extend some aspect of testing machine performance.

78. Gear Checking Instruments

Eastman Kodak Co., Industrial Optical Div.—12-page booklet describes Conju-Gage line of gear checking instruments. Included is discussion of worm section gaging element, gages for making composite check of spur and helical gears up to 8¼-in. pitch diameter, and backlash gage for gears of 5¼-in. pitch diameter and larger.

79. Wood-cased Pencils

J. S. Staedtler, Inc.—Catalog and price list covers complete line of pencils for draftsmen, engineers and architects and includes drawing, thin lead, thick lead colored, colored indelible and colored hectograph pencils. Also listed are Mars-Lumograph drawing pencil and artist pencil, artist lead and many types of refill leads.

80. Technical Facsimile Materials

Technifax Corp.—16-page manual "Diazotype Materials for Ammonia Development" enumerates dry-developing Diazotype materials, machines and supplies for positive-printing process. Standard and nonstandard roll and cut sheet sizes of various types of paper are listed and prices given.

81. Flexible Coupling

Estey Co.—4-page illustrated folder "Estey Articulated Flexible Coupling" describes universal action flexible coupling which utilizes resilient spider molded and bonded in metal retaining ring to allow flexible action of resilient material without distortion.

82. Sprockets and Chains

Diamond Chain Co.—40-page illustrated catalog No. 709 lists various types of stock sprockets and single and multiple-strand roller chains. Data for selection of sprockets and chains, dimensions and prices are listed also.

83. Centralized Lubrication Systems

Alemite Div., Stewart-Warner Corp.—12-page illustrated form 22-154 presents four basic systems of centralized lubrication: Lubrometer, Midget Lubrometer, Dual Progressive and Dual Manifold. Systems are described and compared and tabular data given to permit easy selection of proper system for any given lubrication requirement.

84. Bushings & Bearings

Stripmatic Products, Inc.—1-page illustrated leaflet portrays bushings, bearings, thrust washers, spacers, ferrules, gromets and inserts made to specifications for wide variety of applications.

85. Clutch Head Screw

United Screw & Bolt Corp.—12-page illustrated manual "Clutch Head, the Most Modern Screw" presents details of complete line of recessed head screws which feature nontapered driving engagement; frictional Lock-On; and ability to be driven by common screwdriver, clutch head screwdriver or variety of special bits.

86. Shaded-pole Motor

Russell Electric Co.—4-page illustrated bulletin No. 1000 describes type 230 two-pole skeleton-frame shaded-pole induction motor. Motor can be obtained in ratings from 1/50 to 1/200-hp with load speed of 3000 rpm.

87. In-Line Valves

Ross Operating Valve Co.—8-page illustrated bulletin No. 302 presents data on in-line mounting Master valves and Pilot valves. Typical installation diagrams are given also.

88. Plating Compounds

Wire Coating & Mfg. Co.—4-page illustrated folder is descriptive of method of use of Brite Copper plating compound and Brite Dip after-treatment of zinc or cadmium plate to provide bright corrosion-resistant surface.

89. Centrifugal Castings

Sandusky Foundry & Machine Co.—4-page illustrated bulletin No. 542 indicates facilities for producing nonferrous centrifugal castings in diameters from 3 to 54 in. and in lengths up to 327 in. in wide variety of cylindrical shapes. Physical properties, composition ranges, alloy designations and specifications are charted in single table.

90. Air Motors & Pumps

Gast Mfg. Corp.—12-page illustrated bulletin 449 cites 26 product problems solved with rotary air motors, compressors and vacuum pumps. Air motors from 1/20 to 3-hp, air compressors up to 30 psi and pumps for up to 28-in. vacuum are detailed.

91. Bonded Fabric Bearings

Neveroil Bearings & Bushings—4-page illustrated pamphlet is descriptive of bearings and bushings consisting of lubricant-impregnated fabric, bonded by special process to steel or nonferrous materials and roll-formed to size. Publication charts performance, characteristics and installation of bearings.

92. Pressure Regulators

Air Reduction Sales Co.—32-page illustrated catalog on complete line of pressure regulators includes types for welding, cutting, special flame processes, administering gaseous anesthesia, maintaining gaseous pressures in electrical equipment and other operations where controlled gas pressure is required.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below

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93. Prelubricated Bearings

Westinghouse Electric Corp. — Illustrated booklet B-4378 presents facts about prelubricated bearings used in Life-Line electric motors. Sections discuss desirable qualities of grease, tests to prove adequacy of grease and tests to prove seal effectiveness. Several case histories are cited.

94. Commercial Glassware

Corning Glass Works — 20-page illustrated booklet B-84 describes manufacture and design of comercial glassware. Primary purpose of booklet is to supply background material and data to aid in selecting general design of glass components and accessories.

95. High Nickel Alloys

International Nickel Co.—44-page illustrated technical bulletin No. T-3 is treatise on resistance of high nickel alloys to corrosion caused by sulfuric acid. Problems involving wide range of operations from pickling of steel to petroleum refining and textile processing are discussed.

96. Nut Retainers

Tinnerman Products, Inc.—4-page illustrated bulletin No. 245-2 presents engineering specifications for standard Speed Grip nut retainers. Code is given that explains numbering system for retainers. Selector for panel thickness and tabular information on finishes used are included.

97. Double-Acting Air Cylinders

Bellows Co.—12-page illustrated bulletin PD-120 discusses various types of Power Dome nonrotating double-acting air cylinders. Cylinders listed include single or double-end piston types for foot or side, pivot, rear or front flange, and trunnion mounting.

98. Transmission Belting

United States Rubber Co.—28-page illustrated catalog gives detailed design, engineering and performance data on line of transmission belting. Suggestions for proper selection of belt and procedure for analyzing belt drives are included.

99. Magnetic Motor Starters

Monitor Controller Co.—24-page illustrated catalog No. 6300 presents complete data on Thermaload solenoid type alternating current magnetic motor starters with thermal overload protection for across-the-line starting. They are available in sizes 0 and 1.

100. Split-phase Motors

Emerson Electric Co.—4-page illustrated bulletin B580:A120(M) lists split-phase motors with ratings from 1/20 to 1/3-hp for constant speed operation. Included in listing are general-purpose and special-purpose types with sleeve or ball bearings, either open protected or totally enclosed, and with rigid or resilient mountings.

101. Machine Tools

Ex-Cell-O Corp.—32-page illustrated brochure is entitled "Ex-Cell-O in the Land of Opportunity." Thirty years of production of machine tools and packaging equipment and company's progress in field are reviewed. Production facilities, personnel and equipment produced are portrayed.

102. Oil-hydraulic Products

Commercial Shearing & Stamping Co.—8-page illustrated booklet " 'Commercial' Oil-Hydraulic Products" shows line of pumps with capacities from 1 to 75 gpm; motors rated from 1 to 20 hp; unit, tandem and special valves; multiple and single sleeve cylinders; and manually operated units.

103. Air & Fluid Filters

Skinner Purifiers, Inc.—6-page illustrated bulletin No. 629 is guide to line of filters with cleanable ribbon-type elements. Model R general purpose filters for fine filtration of water, gasoline, oil and other fluids and model RA air filter for separating solids, water and oil impurities from air are described. Flow rate data, installation information and construction features are included.

104. Permanent Magnetic Pulley

Eriez Mfg. Co.—8-page illustrated bulletin No. 510A shows applications and presents data on permanently magnetized nonelectric pulley which provides simple economical means of separating magnetic from nonmagnetic materials conveyed on belt. Magnetic plate separators, drums and traps are shown and described also.

105. Relays & Timers

Struthers-Dunn Inc. — Illustrated "Quick Guide" catalog provides simplified listing of essential data to permit easy selection of relays and timers. Data are arranged so that relays of suitable electrical and mechanical characteristics can be specified for proper application. Information is given also on mounting styles, covers and housings.

106. Welding Fittings

Ohio Nut & Bolt Co.—4-page illustrated bulletin No. 496 shows applications of bolts, knobs, bracket, handle, mounting lug, pin, nuts and open end studs for projection welding and nuts, screws and pins for spot welding.

107. Speed Reducers

Cleveland Worm & Gear Co.—8-page illustrated bulletin "Save Space. . .Save Weight . . .Save Money" is series of case studies on use of Speedaire fan-cooled worm gear speed reducers and resultant savings. Performance data are given on applications of drives to machine tools, process equipment, elevators, conveyors and pumps.

108. Silicone Manufacture

General Electric Co., Chemical Dept.—12-page illustrated bulletin CDC-102 depicts company's silicone manufacturing facilities at Waterford, N. Y. Included are brief descriptions and listings of principal uses of silicone resins, oils, greases, rubber and water repellents.

109. Heat Treated Bearing Metal

American Crucible Products Co.—8-page illustrated pocket-size folder "Promet" discusses properties of heat treated bearing metal which is soft with excellent lubricating properties yet has close structure so that it is resistant to compression and wear.

110. Timing Motor

R. W. Cramer Co.—4-page illustrated bulletin No. 10A describes type SX self-starting synchronous timing motor that operates at 240 rpm on 60-cycle current. Applications, features and construction are discussed and cross-sectional view presented.

111. Pressure Recorder

Bristol Co.—Illustrated bulletin No. G620 describes series 500 absolute pressure gage and gives data on new principle of operation employed which makes it possible to record and automatically control absolute pressure within scale range as low as zero to 20 mm of mercury absolute.

112. Ball Bearings

Marlin-Rockwell Corp.—40-page bulletin No. 26 contains list of bearing numbers of more than 12,500 different ball bearings made by various manufacturers and corresponding sizes of M-R-C replacements.

113. Variable Speed Control

Reeves Pulley Co.—8-page illustrated bulletin No. VN-4912 deals with Vari-Speed Jr. control for light horsepower requirements. Unit delivers infinitely variable speed to any driven machine with speed ratios from 1¾:1 to 2¾:1.

114. Brass Gate Valves

Ohio Brass Co.—Illustrated leaflet "It's the Disc That Makes the Difference" discusses brass gate valves incorporating Flexitite disk which combines strength of solid wedge disk with sufficient flexibility to make tight leakproof contact over entire seat surface.

115. Process Measurement

Foxboro Co.—32-page illustrated bulletin No. 427 presents line of Dynalog instruments for process measurement and control as well as various auxiliary devices which adapt these instruments to many diverse industrial applications.

116. Contactors

Square D Co.—2-page illustrated bulletin 8990 describes contactors for resistance welders. Construction features, applications and ratings for high speed, Synchro-Break and electronic types are given.

117. Abrasion-resistant Alloy

American Brake Shoe Co., Electro-Alloys Div. — 6-page illustrated bulletin T-176 describes how abrasion can be reduced with Thermalloy HC-250. Physical properties and uses are listed and case histories cited that give actual field service data.

118. Centrifugal Clutch

Conway Clutch Co.—4-page illustrated bulletin C-4 describes centrifugal clutch which permits motor or engine to attain predetermined speed before power is applied and disconnects power flow automatically when overload slows down speed of work shaft.

119. Speed Reducers

Cone-Drive Div., Michigan Tool Co.—Illustrated bulletins Nos. 8962 and 8964 explain manner in which standard single reduction Cone-Drive speed reducers are combined to give double reduction output. First publication covers reducers up to 9 hp and 53,700 lb-in. output torque and second, up to 59 hp and 244,600 lb-in. torque.

120. Centralized Lubrication

Trabon Engineering Corp.—4-page illustrated bulletin No. 484 depicts how type M centralized lubrication can be used for machinery of all kinds. Included is question and answer section derived from field service experience.

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NEW TYPE "N" ROTARY SEAL

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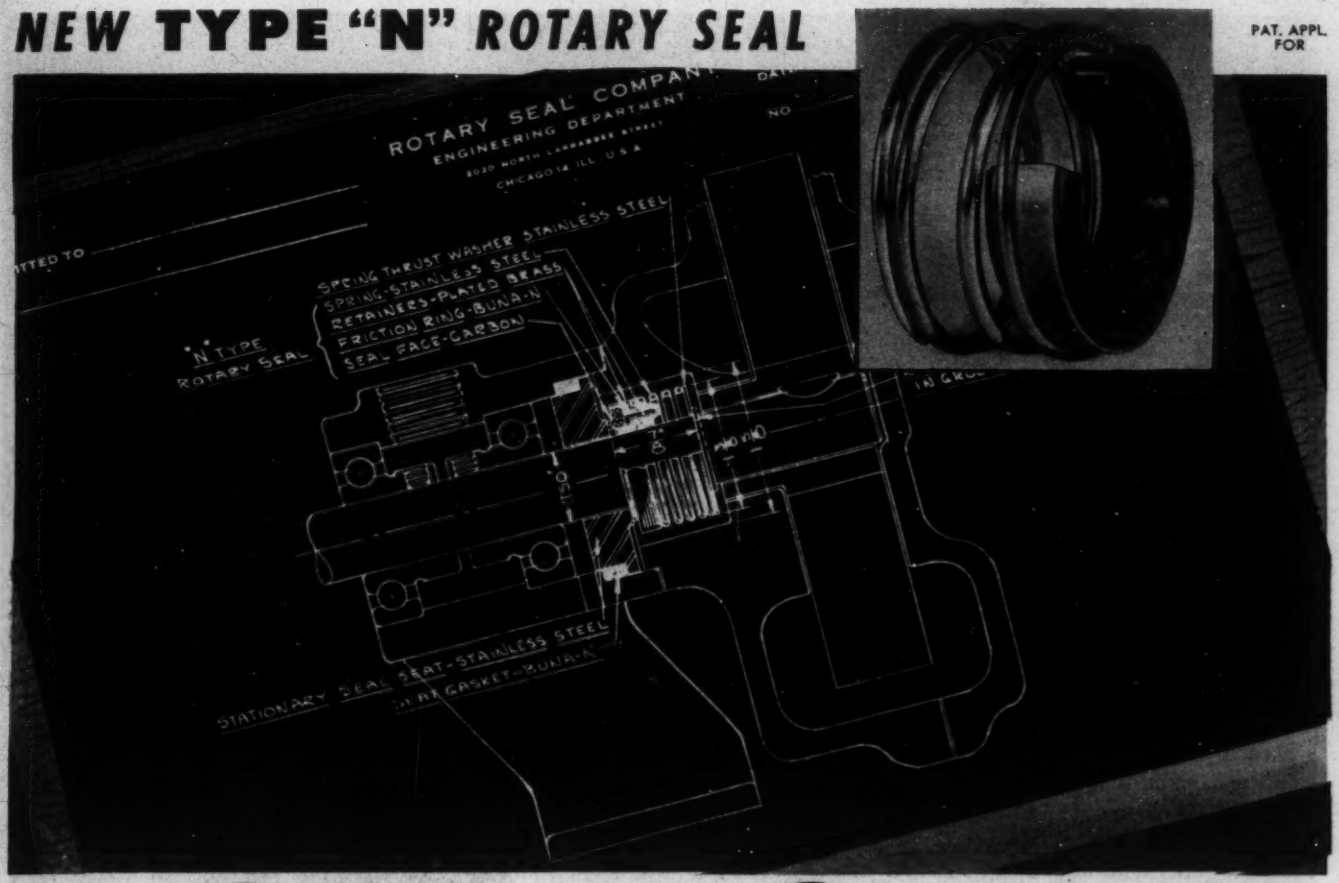

saves *Rejects*-steps up *Production*-lines

There are no loose parts to deal with when you use Type "N" Rotary Seals. Unit construction brings the Seals to your plant pre-assembled and ready to incorporate into your equipment — no "watchmaker" adjustments or fittings to make. Naturally, this means faster production; and at the same time, greater freedom from rejects caused by faulty assembly.

Rotary Seal engineers can quickly adapt this new unit to any of a wide range of applications (although, since Type "N" has been designed particularly to meet mass production conditions, it is not available in small quantities for all shaft sizes). Check with us now to learn how your production can benefit from Type "N" Rotary Seals—the latest development of a time-tested principle, engineered especially to meet the increasingly difficult sealing problems resulting from higher shaft speeds or difficult lubrication conditions.

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is the original approach to a practical solution of a universally troublesome problem. Our booklet "Sealing with Certainty" explains and illustrates the principle. We're glad to send it to you without obligation. Full description of Type "N" is included.

THE ROTARY SEAL COMPANY — mechanical seals for rotating shafts

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PRODUCTION AND DESIGN

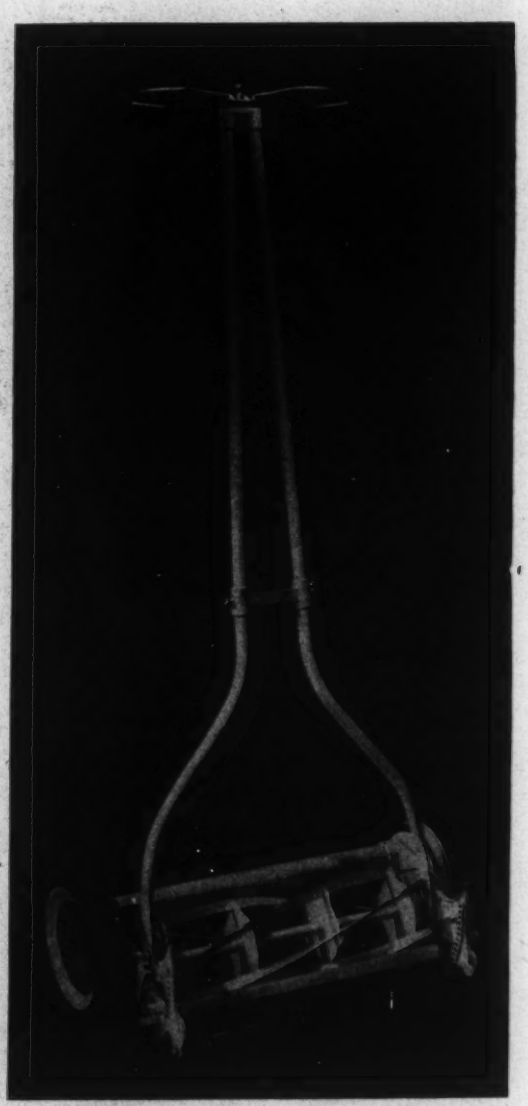
Modern Practices in Manufacture

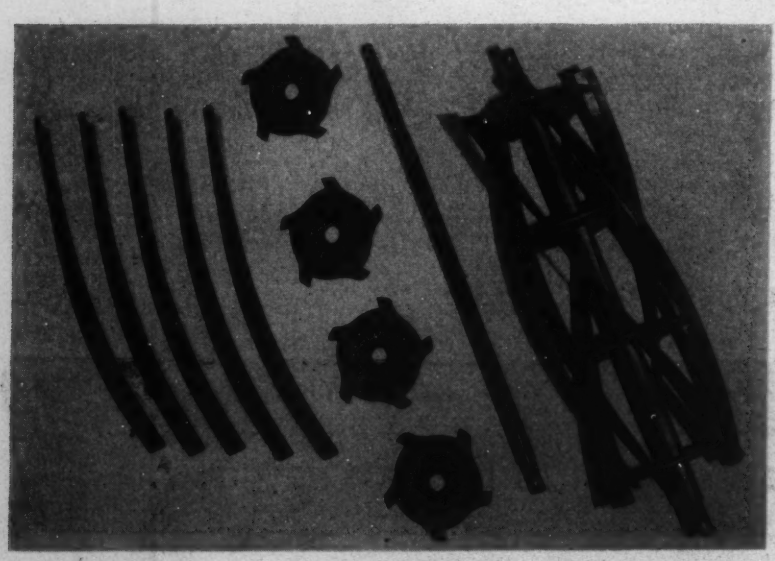
Redesign for Welding

MODERNIZATION of a lawn mower manufactured by the Clemson Brothers Inc. of Middletown, N. Y., involved the redesign of the mower reel for welded steel fabrication to produce a stronger, superior cutting reel. This redesign presented a production welding problem in the joining of dissimilar steels, which is being solved by the application of low-hydrogen, lime-ferritic electrodes.

Previous design of the reel employed cast steel and riveted construction. The new design shown in the accompanying illustrations comprises a cold-rolled steel shaft, spiders stamped from SAE 1020 hot-rolled steel, and cutter blades of high-carbon steel, at least 0.75 per cent carbon. A problem is encountered in welding these elements of dissimilar steels with short ½-inch welds and tack welds so that the reel will withstand severe abuse without failure.

Satisfactory production of the redesigned reel is based on use of LH-70 welding electrodes of low-hydrogen content manufactured by the Lincoln Electric Co. This type of electrode readily deposits a dense, strong, homogeneous weld in steels normally considered to require special welding procedures. Tensile strength of welds as deposited is 75,000 to 80,000 psi. The welded mower reels have far exceeded expectations in performance both in laboratory and field tests.





New Clemson lawn mower, above, and redesigned welded reel, left, showing stamped spiders and formed high-carbon steel blades

PERMA-TUBE may be used for many applications where strength, rigidity, rust-resistance, and attractive appearance are necessary.

By using the new exclusive rust-resisting J&L PERMA-TUBE for the vertical mast and cross-arms in the "Minute-Man" series of television antennas, Ward Products Corporation, Division of the Gabriel Company, Cleveland, Ohio, builds-in the following advantages:

1. **Greater structural rigidity with smooth, attractive appearance. Greater strength to resist ice loads.**
2. **Clearer, steadier, television reception. Less vibration from wind.**
3. **No mechanical seam in Permatube to invite rust which would reduce the torsional strength.**
4. **Ease and speed of installation . . . at less cost.**

J&L PERMA-TUBE is a light-wall, electricweld steel tubing, coated inside and out with an exclusive plastic-type, weather-resistant finish. PERMA-TUBE can be furnished: bent . . . expanded . . . flanged . . . swaged or fluted.

J&L PERMA-TUBE for television antennas, *costs less than any other tubing with comparable strength, rigidity and rust-resistance.*

J&L PERMA-TUBE is not only applicable to television antennas, but also wherever strength, rigidity and rust-resistance are important. It is available in all regular sizes and shapes of J&L Electricweld Tubing and in lengths up to 10 feet. Return the coupon TODAY for complete information on this new J&L product.

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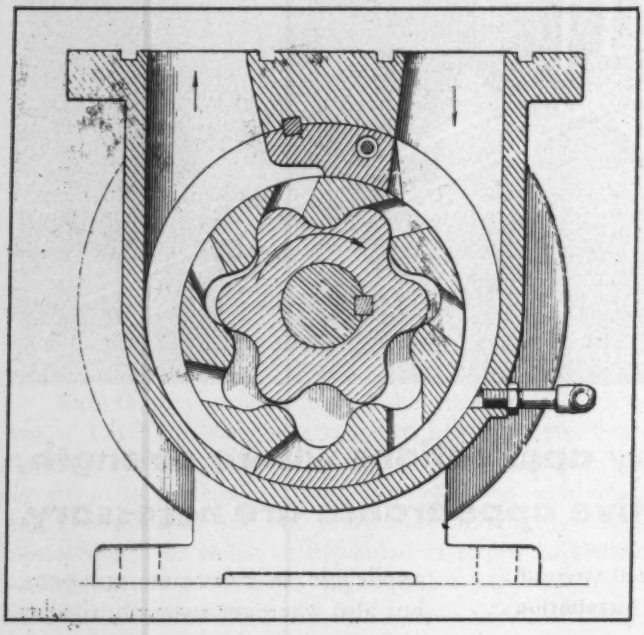
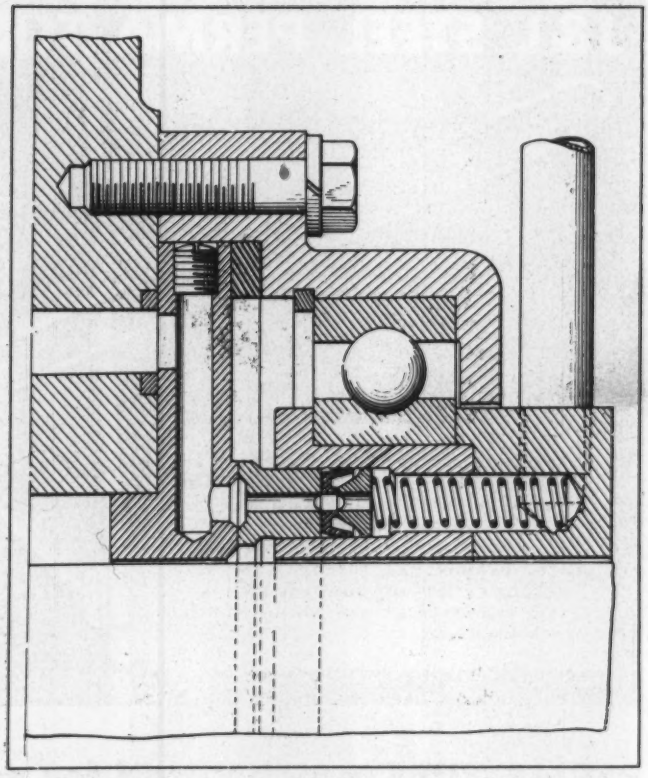
NOTEWORTHY PATENTS

REDUCED SHOCK LOSS and minimum leakage under high discharge pressures are obtained in positive-displacement pinion and ring gear type pumps by designing specially shaped inlet ports in the periphery of the ring gear. Obliquely inclined ports present an advancing, tapered pickup lip that merges smoothly into the contour of the internal tooth space in the ring gear. Fluid is scooped up by rotation of the pinion and ring gear, the incoming fluid being evenly accelerated along the face of the advancing



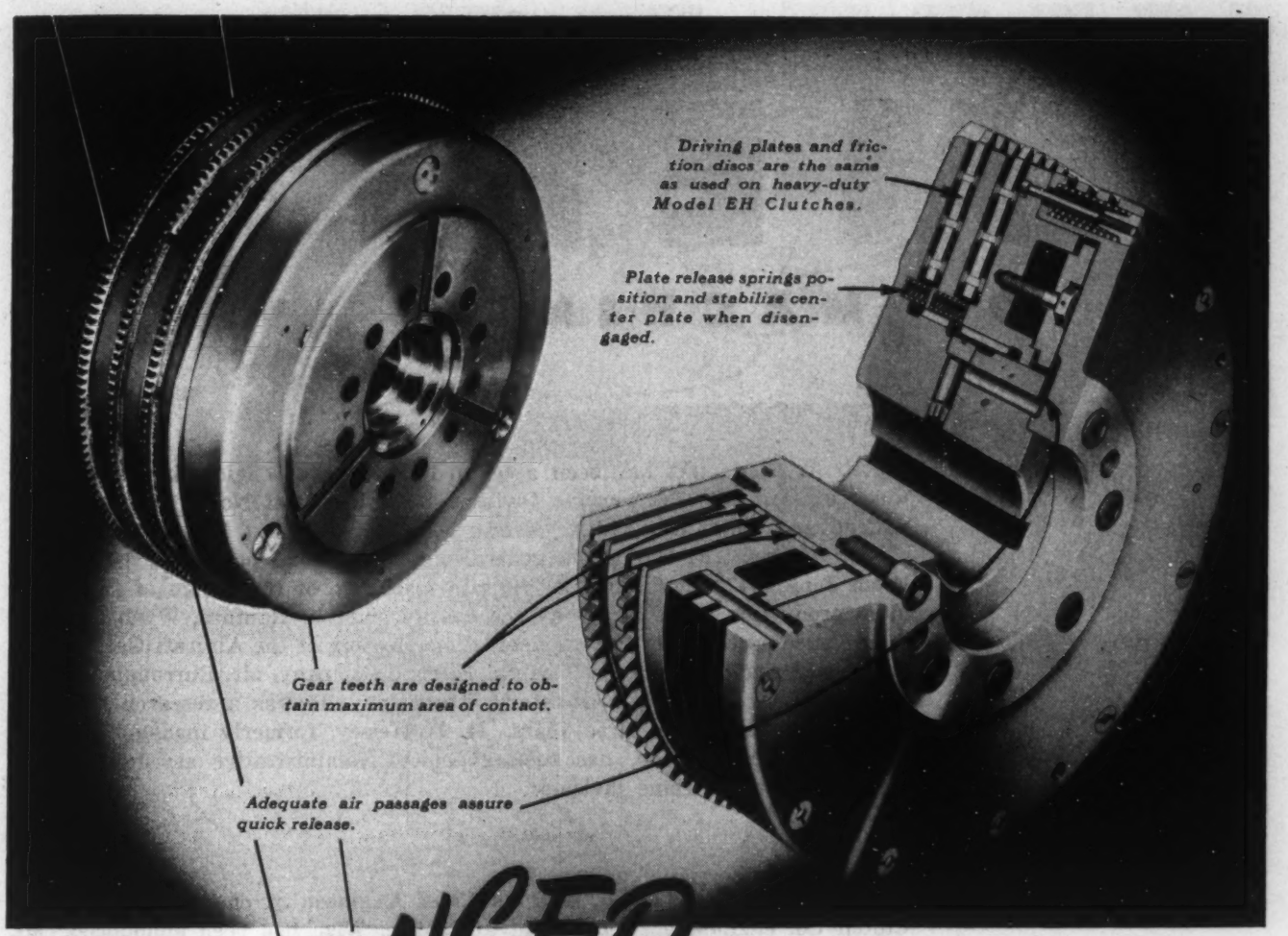
tooth, thereby lessening shock losses and decreasing wear. Patent 2,458,958 assigned to Gulf Research & Development Co., by Reginald J. S. Pigott and Ernest A. Mori.

FLUID SUPPLY through an annular seal around a rotating shaft is accomplished with the arrangement described in patent 2,469,588. A metallic seal ring, secured to the rotating member, contains a series of radial passages leading to an operating chamber, as on an air-actuated clutch. This rotating seal ring bears against a stationary carbon sealing ring which is provided with an annular groove concentric with the shaft and opening into a similar groove in the rotating ring. Drilled passages lead from the groove in the stationary ring back to the fluid supply line. Fluid flows through these passages and into the adjacent grooves in the two seal rings, then through



the radial passages in the rotating ring and into the operating chamber. The one-piece, spring-loaded carbon seal ring dissipates heat evenly and enables an even pressure to be obtained on the metallic seal ring. The design obviates drilling a fluid passage hole through the shaft and reduces the overall length of the seal as compared to a shaft-end type seal. George R. Aschauer has assigned the patent to Twin Disc Clutch Co.

DUAL-SPEED GOVERNING of commercial vehicles permits one top engine speed while in high gear and a higher engine speed when in lower gear, thus preventing decreased performance in the lower gear positions. In high gear, a conventional centrifugal flyball governor acts against a single tension spring to give the desired throttle control. Shifting into a lower gear causes another spring to come into action, requiring the governor to act against an increased force and permitting a higher engine speed. Walter M. May and Laurence E. Burgess have assigned the patent, No. 2,474,316 to the Mack Manufacturing Corp.



BALANCED ...for work, wear, heat

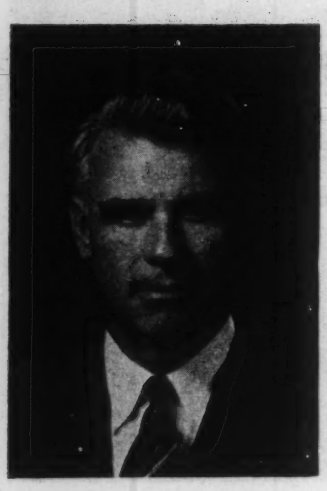
Experience has proved the mechanical proportions of the Twin Disc Models P and PH Air-actuated Clutches to be in proper balance for efficient work, for long wear-life, and to absorb and dissipate heat . . . essential qualities in heavy-duty clutch installations.

Twin Disc Air-actuated Clutches also permit operation by remote control without complicated linkage systems. They require less shaft space, thereby permitting closer shaft bearing center distances. Gear teeth are designed to obtain maximum area of contact. Multiple springs assure quick release and equal distribution of release pressure. Properly installed, these Clutches require no adjustments to maintain the correct pressure on the friction discs . . . an important factor in obtaining longer wear-life. Model P and PH Clutches are available in sizes from 14 to 42″, capacities from 75 up to 1325 hp.

If you have a heavy-duty clutch application requiring operation by remote control, write the Twin Disc Clutch Company for their engineers' recommendations. Ask for Bulletin No. 139-A. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

MEN OF MACHINES



R. E. Burroughs

R. E. Burroughs has been appointed manager of engineering of General Electric's Aircraft Gas Turbine Division. A graduate of North Carolina State College and Duke University, he has been with General Electric since 1946 when he joined the company's general engineering and consulting laboratory. From June 1947 until July 1948 he was in charge of the design of the plutonium production areas at the atomic energy plant in Hanford, Wash. He was then named assistant to the manager of engineering of the Aircraft Gas Turbine Division. Prior to joining the General Electric Company, Mr. Burroughs worked for the Kodak Research Laboratory, Rochester, and was a research fellow at Purdue University for three years. **H. D. Kelsey,** formerly manager of engineering of the division, has been appointed administrative assistant to the manager of the turbine divisions.

♦

Lloyd Wolf

Appointment of **Lloyd Wolf** as Chief Engineer in charge of Twin Disc Clutch Co. engineering department at Racine, Wis., has been announced. Mr. Wolf joined Twin Disc in July, 1947 as chief development engineer, prior to which he was associated with Gemmek Manufacturing Co., Mechanical Handling Systems Inc., Continental Motors and General Motors Corp. in engineering capacities. During the war he was chief engineer of Army Ground Forces at Fort Knox, Ky., where he was primarily concerned with the development of hydraulic power transmissions for the Army's heavy tank program.

♦

Charles M. Slack has been named technical director of the Westinghouse Electric Corp. Atomic Power Division. In his new position he will have staff responsibility for the general direction and coordination of all research and engineering work of the division. Dr. Slack was graduated from the University of Georgia in 1922 and received both his Master's and Doctor's degrees from Columbia University. He joined Westinghouse as a physicist in 1927, became director of research for the lamp division in 1943 and was named research director in December, 1946. Author of many scientific articles he is a member of the American Institute of Electrical Engineers, the American Association for the Advancement of Science and the American Physical Society.

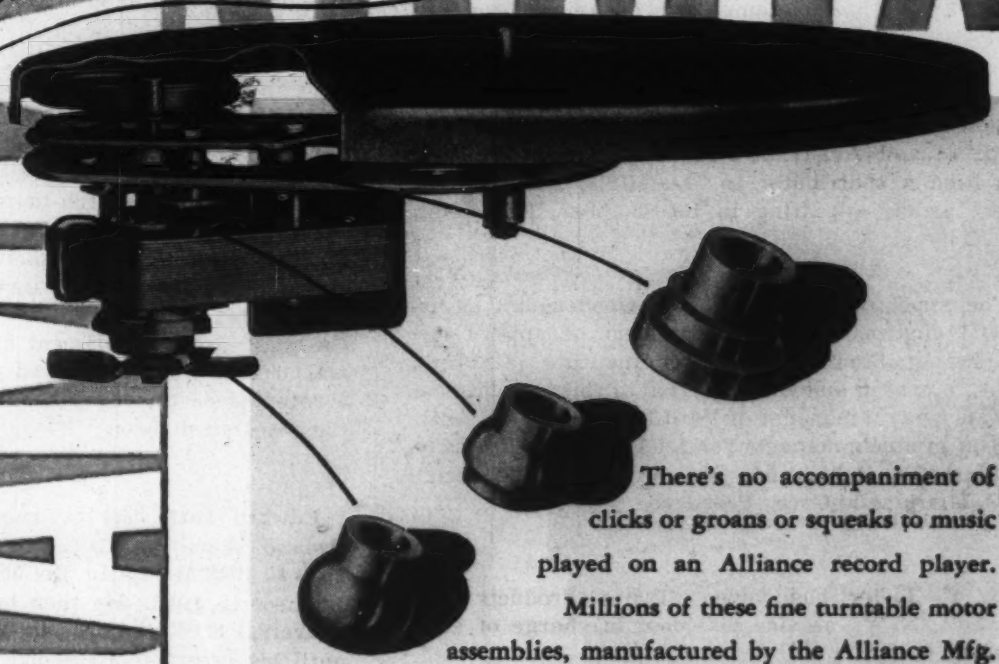
Charles M. Slack

♦

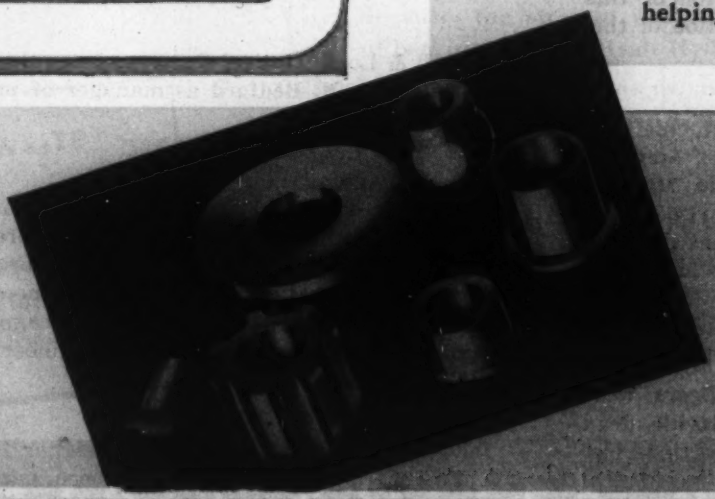
Announcement has been made of the addition in the applied mechanics research department of of **Wilhelm Spannhake** as chief research scientist of Technology. In the past Dr. Spannhake was Armour Research Foundation of Illinois Institute employed by the Vulcan Works of Stettin and

GRAMIX

GRAMIX bearings help insure quiet operation of record player



There's no accompaniment of clicks or groans or squeaks to music played on an Alliance record player. Millions of these fine turntable motor assemblies, manufactured by the Alliance Mfg. Co. of Alliance, Ohio, operates *smoothly, silently —and at constant speed*—thanks largely to three little Gramix bearings. Two self-aligning bearings in the motor and a double flange bearing on the main shaft are not only helping Alliance units give better service but they are also helping Alliance cut their cost of manufacture.



Because bearings, gears and other Gramix parts are die-pressed of powdered metal, they cost far less than machined parts, *sometimes as much as 80% less.* And because they can be impregnated with lubricants, further lubrication of Gramix parts is often unnecessary. Our engineers may be able to show how Gramix can help you improve mechanical performance and cut manufacturing costs in your products. Write today for free copy of the 264 page Gramix catalog.

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Hamburg, Neumeyer Co., Karlsruhe Technische Hochschule, Massachusetts Institute of Technology and the David Taylor Model Basin of the Navy Department.

♦

W. E. Mahin, chairman of metals research at Armour Research Foundation of Illinois Institute of Technology, Chicago, has been named director of research. For ten years prior to his joining the Research Foundation in 1947 Mr. Mahin was in charge of metallurgical engineering at Westinghouse Electric Corp., Pittsburgh. A graduate of Notre Dame and Carnegie Institute of Technology, he has also been associated with Vanadium Corp. of America and Inland Steel Co. He is a member of the American Society for Testing Materials, American Society for Metals, American Institute of Mining and Metallurgical Engineers, Institute of Metals, British Iron and Steel Institute and American Foundrymen's Society. He has been a contributor to MACHINE DESIGN, his latest article appearing in the October, 1947 issue.

♦

The appointment of **James G. Goodenough** as assistant chairman of the department of applied mechanics at Stanford Research Institute, Stanford, Calif., has been announced. Prior to this appointment he was general manager of Vard Inc., Pasadena, Calif., special products manager for Adel Precision Products, of Burbank, Calif., and chief of engineering design of G. M. Giannini Corp., Pasadena.

♦

R. E. Lister has joined Skyline Products Inc., Jamaica, N. Y., as vice president in charge of engineering.

♦

Andrew Kalitinsky, chief engineer of the NEPA division of Fairchild Engine & Airplane Corp., Oak Ridge, Tenn., has been awarded the 1948 Manly Memorial Medal of the Society of Automotive Engineers for his paper "Atomic Power and Aircraft Propulsion" which was presented before several sections of the Society during 1948. A condensation of this paper appears in the Design Abstracts section of this issue.

♦

B. J. Fletcher has been named assistant chief hydraulic engineer for Aluminum Company of America, Pittsburgh. Mr. Fletcher joined Alcoa in 1926 as a member of the hydraulic engineering department and in 1931 was transferred to the development division, being made chief engineer of that division in 1944.

♦

At a recent meeting of the American Society for Engineering Education the following officers were elected for the year 1949-50: **Thorndike Saville,** dean of the New York University College of Engineering, president; **B. J. Robertson,** professor of mechanical engineering, University of Minnesota and **H. H. Armsby,** specialist in engineering education, U. S. Office of Education, vice presidents; **F. E. Terman,** dean of engineering at Stanford University, vice president in charge of the engineering college administrative council; **F. M. Dawson,** dean of engineering, University of Iowa, continues as vice president in charge of the engineering college research council; and **James S. Thompson,** formerly vice-chairman of the board of directors of McGraw-Hill Book Co., was re-elected treasurer.

♦

Melvin N. Osborn has recently been promoted from senior layout draftsman to senior project engineer of the Allison Division of General Motors Corp., Indianapolis.

♦

Fairbanks, Morse & Co., Chicago, announce the appointment of **Frank M. Mason, Jr.** as director of engineering. Mr. Mason, who has for several years been manager of the research division in charge of all research, developments and patents, joined the company in 1922 following his graduation from Northwestern University, Massachusetts Institute of Technology and Washington University. He was first employed in the engineering department at the Indianapolis plant and in 1923 was transferred to St. Louis to organize a patent department for the firm. In 1925 he entered the research division.

♦

Edward Latta has returned to Redmond Co. Inc., Owosso, Mich., as a special project engineer. From 1939 to 1946 Mr. Latta was with Redmond, being chief engineer in 1946. He then became chief engineer of Universal Electric Corp., in which capacity he served until his return to Redmond. Others assigned to the new project engineering section are **George C. Morris, John T. Howes** and **F. Richard Merriam.**

♦

Chester A. Arents has been appointed assistant dean of engineering at Illinois Institute of Technology, Chicago.

♦

Bausch & Lomb Optical Co. announces the appointment of **Harry N. Bedford** as manager of production planning and control.

♦

Geuder, Paeschke & Frey Co., Milwaukee, announces the appointment of **Harry L. Stiles** as vice president in charge of engineering. A graduate of Massachusetts Institute of Technology he comes to his new position after being managing engineer for Chicago Electric Manufacturing Co., and commercial engineer for General Electric Co.

♦

John H. Bauer, formerly chief designer for Peterson Engineering Co., Toledo, has been named chief engineer of the Toledo Desk and Fixture Co., Maumee, O.

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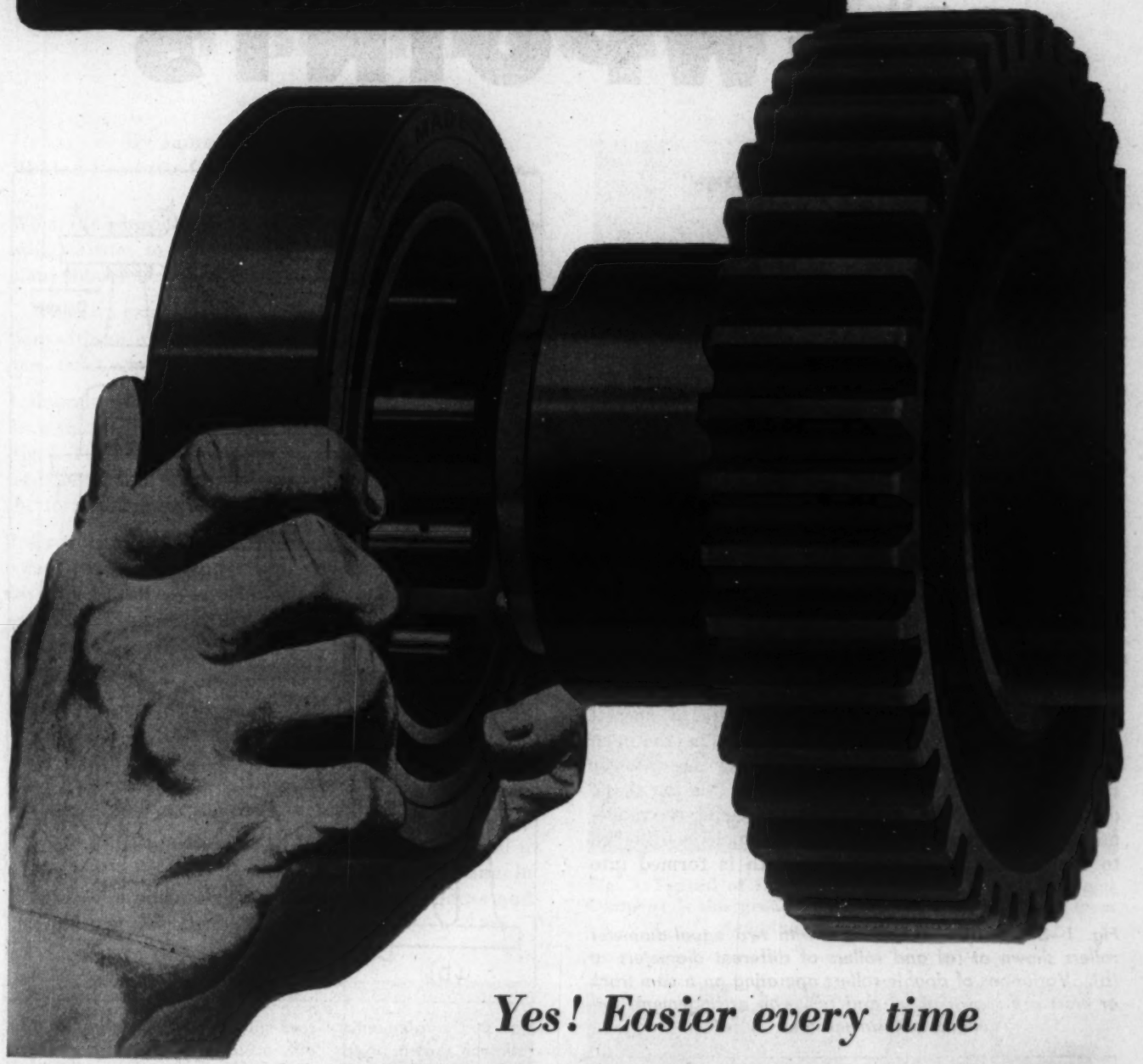

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HYATT ROLLER BEARINGS

PROFESSIONAL VIEWPOINTS

". . . complementary cam design"

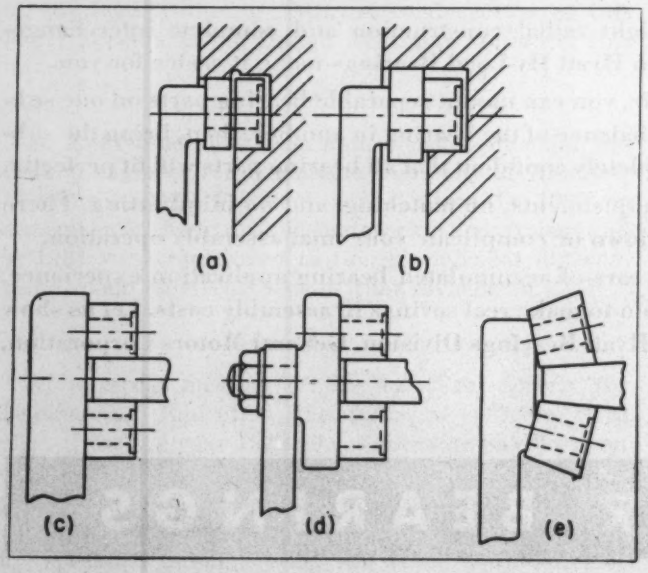
To the Editor:

An article on cam design by Prof. J. A. Hrones (MACHINE DESIGN, June, 1949, Pages 124-125) mentions correctly that in a closed type cam excessive clearance has to be avoided and recommends as a way out the use of a double-roller assembly. It is implied but not mentioned specifically that one roller cannot roll simultaneously on two surfaces, and therefore the single-roller idea in a closed cam is bad.

There exist a number of other solutions besides the double track cam shown, *Fig.* 1*a*, where the undercutting of the outer track may cause some difficulties. An alternative is to use rollers of different diameters in a track milled out in the usual way, the difference in roller diameters being small enough to not impair the accuracy of the cam movement, as in *Fig.* 1*b*.

Closed cams and crests are difficult to produce and therefore the idea of using open cams and obtaining form constraint by using a complementary open cam has found much interest with designers of special machines. In such an arrangement, *Fig.* 2*a*, the open main cam a_1 is designed as usual, giving the follower roller b_1 the required movement. After this the shape of the complementary cam a_2 is found, using the movement that is imparted to roller b_2 which is attached to the sliding follower b. This path is formed into a complementary cam ensuring the form closure or constraint of follower b. The two cams a_1 and a_2 have a common axis and are fixed together. These two cams will act as a single unit if a line between the two follower centers, b_1 and b_2, intersects the common center of the cams and if this center distance remains constant. In such a case the cam assumes a symmetrical shape and motion for both the forward and return stroke becomes the same. Although it is extremely difficult to make a closed cam adjustable, i.e., to vary its law of motions, it is not so difficult with open cams; hence the principle of main and complementary cams may permit some adjustment.

Fig. 1—Double-rack closed cam with two equal-diameter rollers shown at (a) and rollers of different diameters at (b). Variations of double rollers operating on a cam track or crest are shown at (c) and (d), with arrangement permitting adjustment seen at (e)



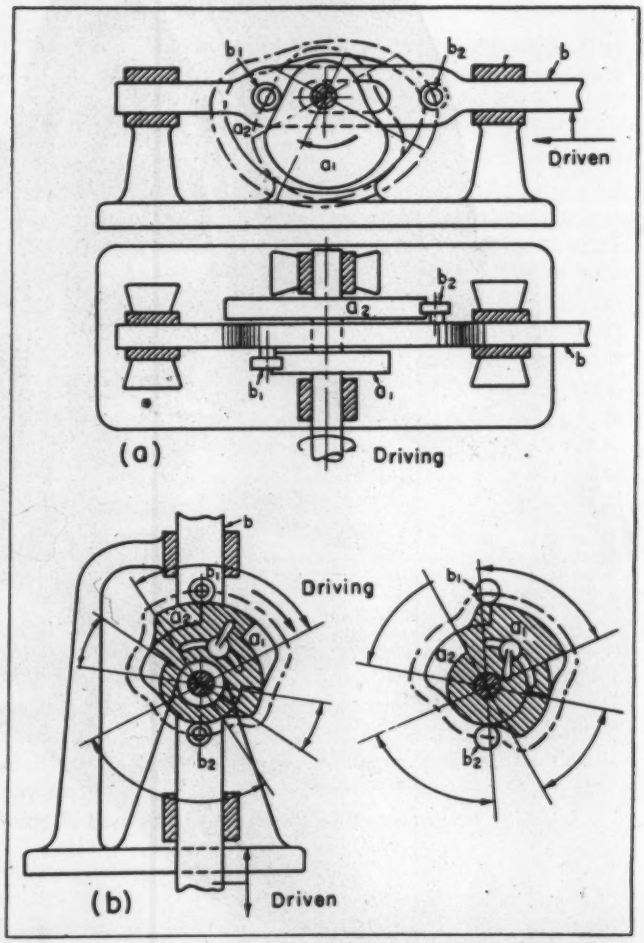


Fig. 2—Complementary cam mechanism operating a slide follower shown at (a), with adjustable cam arrangement, (b), allowing for different cam pauses

—PAUL GRODZINSKI
Mechanical Engineer
London, England

There's More than One Way to Bear Down on Costs

By James B. Scott, President
Welded Products Company, Grand Haven, Michigan

When the backfield runner hits the line and finds a stone wall, he tries to skirt around it for yardage. Likewise, many shops follow these tactics in the tussle for lower costs.

When we can make no further headway in cost reduction with an existing method, we often manage to find new, fresh approaches to the problem. For example:

1. Examine the design. To improve the cast sprocket for a chicken feeder, we used two stampings as shown in Fig. 1. The resultant sprocket operates better because the feed doesn't jam in the teeth. To get the same results with the former design would have cost considerably more.

2. Examine the set-up. We were nip and tuck with competition (another process) on a machine base. By devising an improved clamping and positioning fixture, we speeded up output from 5 bases to 9 bases per day —cut unit cost $2.20 each.

3. Examine the welding procedure. Types and sizes of electrodes . . . amperage . . . A.C. or D.C. . . . these factors are weighed in setting up the procedure for each job. On a recent cold-rolled steel job, we used "Shield-Arc LH-70" electrodes and eliminated pin-holes, speeding up welding and cutting costs.

In all of our efforts to bear down on costs, we find it extremely helpful to have the advice of the Lincoln Welding Engineer, and we use Lincoln Welders and Electrodes practically 100%.

Fig. 1. Changeover of this chicken-feeder sprocket to welded stampings eliminated feed jamming.

Fig. 3. Typical of the welding output of Welded Products Company is this group of engine brackets, fabricated from stampings and shear-cut plate.

Fig. 2. Two points of attack on welding costs: Left—Duane Brady and James Scott work on the modification of a product design. Right—Ingenuity is applied to the design of fixtures and the planning of welding procedure for each product.

The above is published by **THE LINCOLN ELECTRIC COMPANY** *in the interests of progress.*
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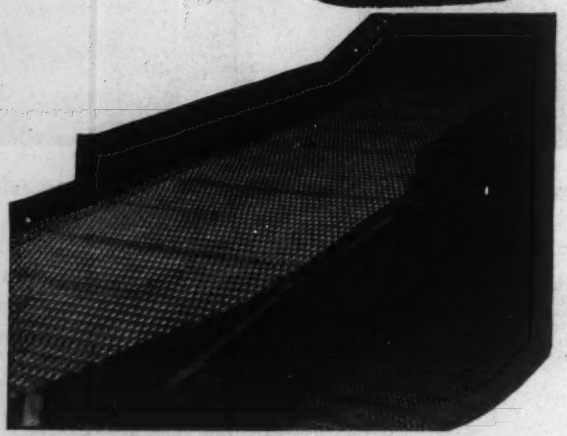

A typical Cambridge Balanced Belt on a package conveyor. Such belts can speedily and economically handle all types of packages, products or raw materials. Dirt and dust sift through open mesh for extra cleanliness.

Whether your products are treated with heat, cold or corrosive agents, you can get a faster, more economical output by combining processing with product movement on a Cambridge woven wire conveyor belt.

SPEED—because the moving belt permits *continuous* treatment, ends time-wasting machine stops.

ECONOMY—because the belt reduces manual handling. In most cases one loader is adequate to feed the belt.

DURABILITY—because the wire belt for your particular installation is made from the specific metal or alloy to the mesh or weave best suited to your requirements.

Call in your Cambridge Field Engineer whenever you have a problem combining movement with processing.

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Hardenability and Steel Selection

By Walter Crafts, chief metallurgist, and John L. Lamont, research metallurgist, Union Carbide and Carbon Research Laboratories Inc.; published by Pitman Publishing Corp., New York; 279 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, *$5.50 postpaid.*

Designers, materials engineers, and metallurgists who are responsible for the selection and heat treatment of steel should find in this book a well assembled treatment of the whole pattern of hardenability equations, tables and graphs. Since 1940 this pattern has been largely responsible for the trend toward purchase of steel by hardenability rather than chemical composition.

Consolidating and summarizing the volume of development work well supported by fact, the authors approach the pattern practically but with sufficient theory to explain the practice. It is borne out that hardenability calculations represent quantitative prediction of behavior for each step in the process of economically developing reliable qualities in the finished product. These separate steps involve the evaluation of quenching rates, depth of hardening in quenching, softening and toughening in tempering, and the effects of chemical composition on the evaluation and on the resulting mechanical properties.

Aside from discussing in detail the methods that have been developed for calculating the essentials of heat treatment for desired microstructure, strength and toughness, the authors discuss the matter of selection of steel emphasizing the appraisal of service requirements and the interpretation into tangible mechanical properties.

□ □ □

Analytical Mechanics of Gears

By Earle Buckingham, professor of mechanical engineering, Massachusetts Institute of Technology; published by the McGraw-Hill Book Co. Inc., New York; 546 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, *$10.00 postpaid.*

This is a purely mathematical and analytical approach to a single type of mechanical element, gears, which should assist the designer immeasurably in the development of effective design for any purpose.

Conjugate gear-tooth action, nature of contact and resulting gear-tooth profiles are discussed in the opening chapters. The gears analyzed include spur, internal, helical, spiral, worm, bevel, and hypoid or skew bevel. Spur, internal and helical gears are used to drive parallel axes; bevel, to drive intersecting axes; spiral, worm and hypoid, to drive nonparallel, nonintersecting axes.

The closing chapters analyze gear teeth in action. These discussions include frictional heat of operation

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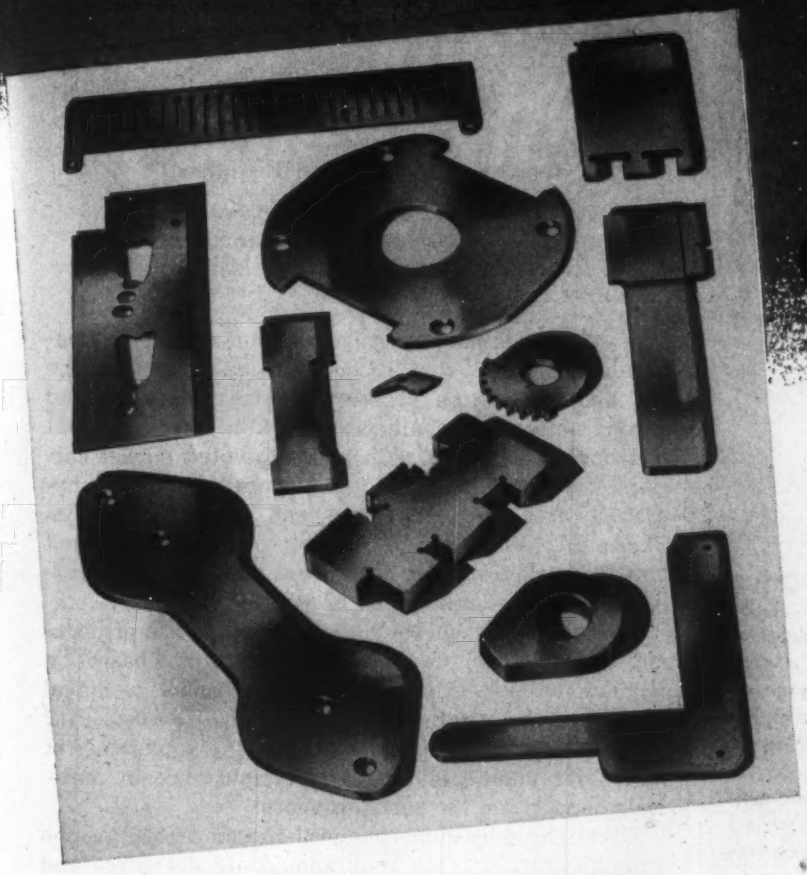

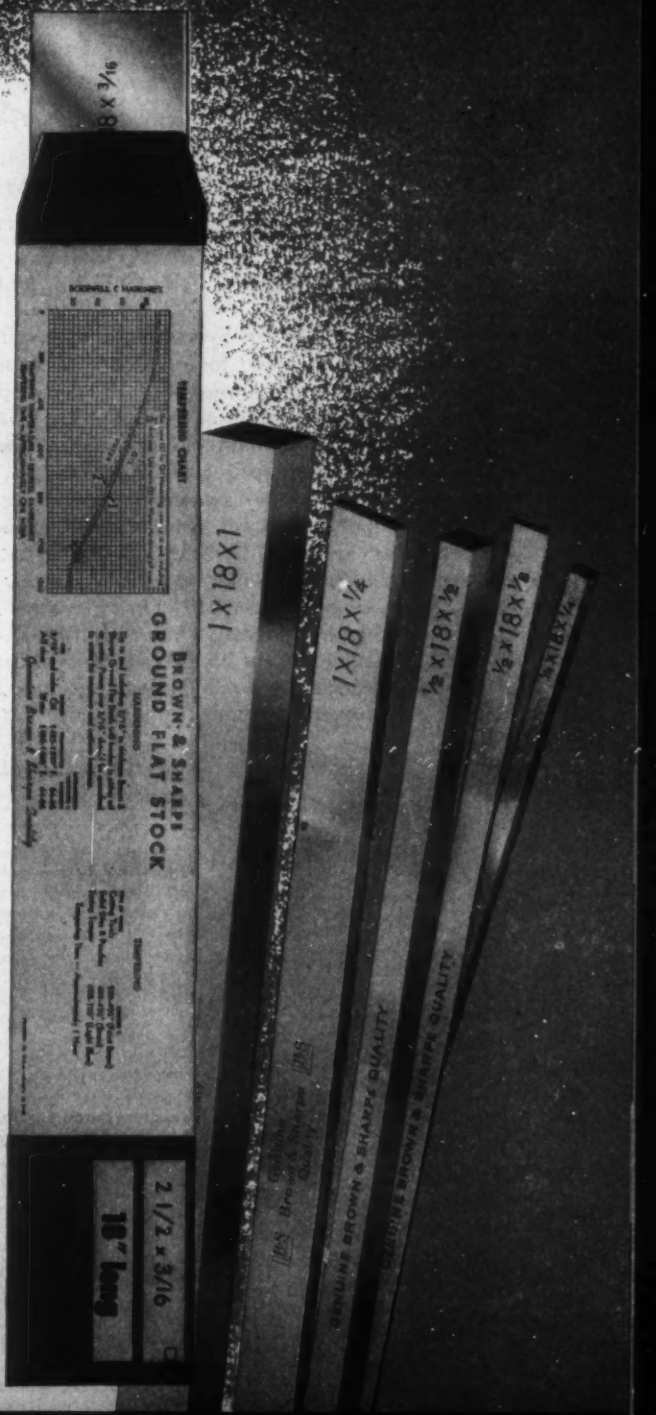

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For compactness, flexibility, accuracy and uniform timing performance . . . specify the Cramer Type SX Motor.

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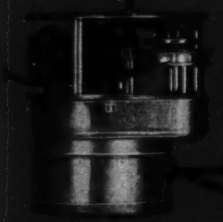

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and its dissipation, friction losses and efficiencies, dynamic loads in operation, beam strength or resistance of the teeth to breakage and fatigue, surface-endurance limits of materials, and the limiting wear loads or the potential resistance to surface disintegration and excessive wear.

□ □ □

Conveyors and Related Equipment

By Wilbur G. Hudson; published by John Wiley & Sons Inc., New York; 468 *pages,* 6 *by* 9 *inches, clothbound; available through* MACHINE DESIGN, $7.00 *postpaid.*

A comprehensive coverage of the science of materials handling, this second edition describes the use and application of screw conveyors, flight and apron conveyors, chain and bucket elevators, belt and bucket elevators, skip hoists, pivoted bucket carriers, overhead trams and conveyors, pneumatic, hydraulic and belt conveyors, and aerial tramways. These different types of equipment are treated not only construction and designwise, but are also analyzed from the standpoint of efficiency in service.

This revision includes extended discussions of pneumatic conveying; dust explosion hazards (based on Bureau of Mines investigations); recent technical improvements which make belt conveyors suitable for greater lengths and capacities; and the application of motorized industrial trucks, of importance in materials handling in the past few years.

Highlighted by numerous well-chosen tables, graphs and illustrations, this book should aid designers and engineers in the selection of materials handling equipment which will best meet their needs operationally and economically.

□ □ □

Evaluation of Residual Stress

By K. Heindlhofer, physicist, United States Steel Corp.; published by McGraw-Hill Book Co. Inc., New York; 196 *pages,* 5½ *by* 8 *inches, clothbound; available through* MACHINE DESIGN, $4.00 *postpaid.*

With the advent of such instruments as the electric-resistance strain gage and the back-reflection x-ray camera, studies of residual stress, paramount to design and materials engineers, have progressed to the point where an organized reference of up-to-date developments is needed. The author has prepared this book to help fill that need.

Following an exposition of the significance of residual stress, the author discusses the limitation imposed on stress analysis by anistropy as exhibited by metals having a pronounced preferred orientation. Pertinent phases of the theory of elasticity and the critical representation of the data are then treated, and the impossibility of calculating residual stress within the body from observations restricted to the surface are discussed. Two chapters are devoted to discussions regarding the proper procedures and use of recently invented instruments, such as electric

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This silicone insulated motor is only about ½ the size and weight of the motor formerly used, yet, it is still performing the same work after 8 months without failure. That's what is meant when we say Dow Corning Silicone Electrical Insulation gives you more power per pound, greater reliability, reduced maintenance costs and increased production.

Every day, more and more engineers are specifying DC Silicone Electrical Insulation in motors exposed to excessive heat, moisture, or heavy overloads. If you would like to learn why these engineers are relying on Silicone Insulation, phone our nearest branch office or write for booklet W-11.

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Photo courtesy Standard Gypsum Company of California

Dow Corning FIRST IN SILICONES

strain gages, in the effective study of residual stress. The book concludes with a presentation of examples of residual stress.

□ □ □

Cylinder Wear in Diesel Engines

By Carl Hoegh; published by the Chemical Publishing Co. Inc., Brooklyn, N. Y.; 243 pages, 5½ by 8½ inches, clothbound; available through MACHINE DESIGN, *$5.00 postpaid.*

Although this book is written with special view to large marine units, a great percentage of the data presented can be effectively used by all designers and engineers in the internal-combustion engine field and by metallurgists and lubrication engineers.

Informatively discussed are piston ring design, lubrication, fuel, ignition and combustion, pressure, temperature, and deposit with emphasis paid to the degree of wear contributed by each; proposals for remedying the effects of the foregoing factors, and also proposals for increasing diesel efficiency are summarized. A chapter is devoted to materials used for cylinder construction, their surface treatment and the tests conducted to determine the material best suited for wear.

Considerable graphical and tabular data is presented in the addendum to validate discussions with major emphasis here being laid to large low-speed marine engines.

De Laval Engineering Handbook is replete with tabular and graphical data as well as informative discussions of steam turbines, centrifugal pumps, IMO pumps, compressors, blowers, exhausters, and helical and worm reduction gears. Published to facilitate the work of power plant, industrial and design engineers, the 255-page book can be purchased from the De Laval Steam Turbine Co., Trenton 2, N. J. for $2.00.

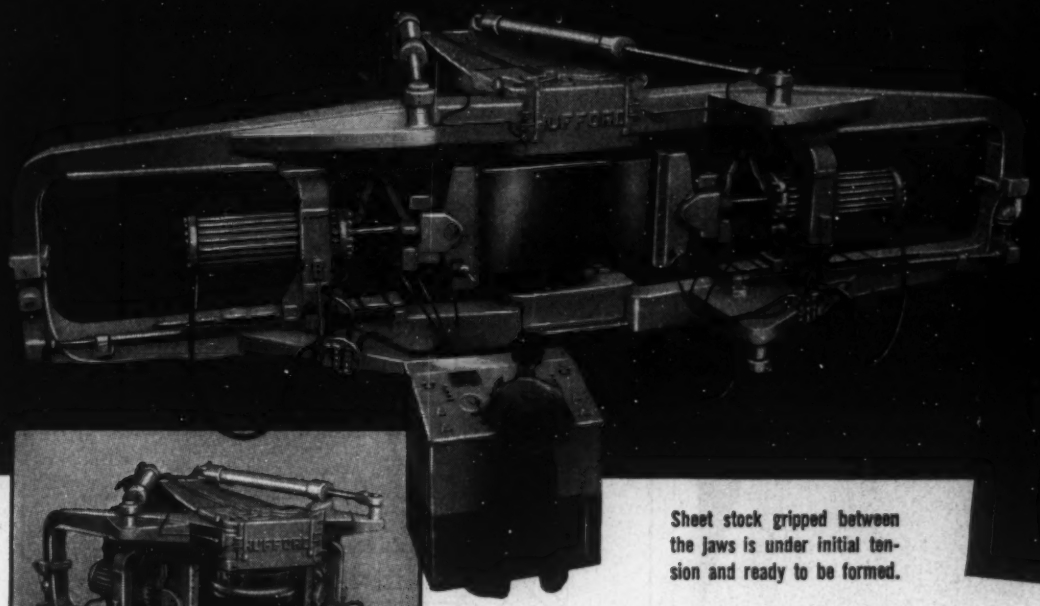
Foundry cost fundamentals are displayed in simple, graphic form in the Gray Iron Society's revised *Cost Manual.* Orders should be addressed to Gray Iron Founder's Society Inc., 210 National City-East Sixth Building, Cleveland 14, Ohio. Price per copy is $5.00.

NEW STANDARDS. Tentative drafts of the following proposed American Standards are being distributed for comment:

Wrought-Steel and Wrought-Iron Pipe, ASA B36 . . .
High-Strength High-Temperature Internal Wrenching Bolts, ASA B18 . . .
Involute Serrations, ASA B5 . . .
Milling Cutters, ASA B5 . . .
Fine-Pitch Straight Bevel Gears, ASA B6 . . .
20-Degree Involute Fine-Pitch System for Spur and Helical Gearing, ASA B6 . . .
Design for Fine-Pitch Worm Gearing, ASA B6 . . .

Engineers concerned with the subjects of these standards may obtain copies by writing to S. A. Tucker, standards manager, The American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

HUFFORD HYDRAULIC STRETCH-FORMING MACHINES



Sheet stock gripped between the jaws is under initial tension and ready to be formed.

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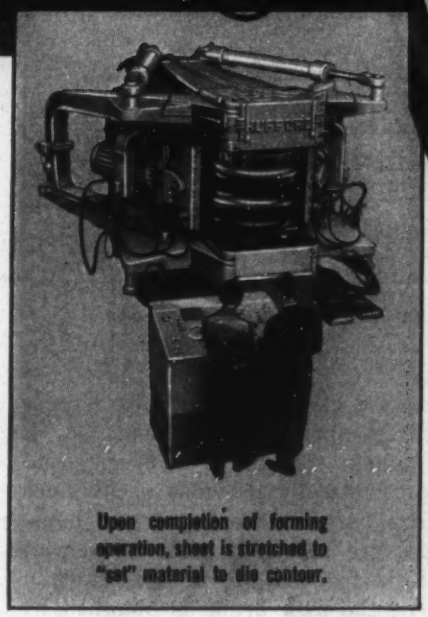

Upon completion of forming operation, sheet is stretched to "set" material to die contour.

A vital factor in the economy, high production and accuracy of Hufford Hydraulic Stretch-Forming Machines is the Vickers Hydraulic Equipment used for both power and control. On the Model 50 machine shown here, the power is furnished by Vickers Balanced Vane Type pumps (two-pressure and single); all the hydraulic control valves are also Vickers. The required versatility is provided, and the control of complex movements is easy and accurate. All controls are handled by "finger touch" levers in the control panel.

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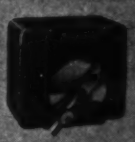

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Mac-it Hollow Pipe Plugs — for accuracy, safety, uniformity and strength

BETTER, FASTER SERVICE WITH THIS *COMPLETE* MAC-IT LINE!

Because many standard types of Mac-its are stocked throughout the country for quick delivery, and because specials can be engineered to your own specifications, you'll find it pays to investigate Mac-its *first.*

Mac-it's 35 years' experience in the manufacture of heat-treated, alloy steel screws is your assurance of precision, uniformity and strength. Sold through leading industrial distributors from coast to coast and in Canada. Write for new catalog today!

Other Mac-it products include:

Hollow Lock Screws
Socket Head Cap Screws
Hollow Set Screws
Stripper Bolts
Socket Screw Keys
Square Head Set Screws
Hexagon Head Cap Screws
. . . and many others

Manufactured Nationally Since 1913 By
STRONG, CARLISLE & HAMMOND COMPANY
Cleveland 13, Ohio
Manufactured by MAC-IT PARTS COMPANY, Lancaster, Pa.

DISK BRAKE

(*Concluded from Page* 126)

chors, bearing against the pressure plates to prevent rattling due to any slight radial motion.

Four return coil springs are used in each brake assembly and act in the same way as return springs in shoe-type brakes in that they pull the pressure plates together when hydraulic pressure is released and prevent the plates from dragging.

An interesting adjusting mechanism has been worked out to compensate automatically for lining wear so that full pedal effectiveness is maintained. There are two identical units mounted on each inner pressure plate diametrically opposed. A floating steel pin is located between lugs on the outer pressure plate and is held by the wedging action of a spring-loaded steel washer at one end, *Fig.* 4. A groove in the base plate near one flange keeps the

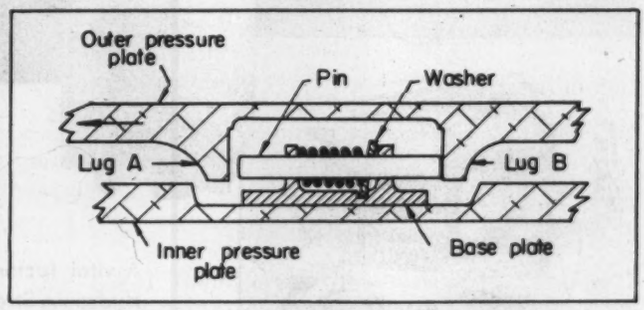


Fig. 5—Arrangement with self-adjusting mechanism

washer in a cocked, or locked, position with respect to the pin while the washer is under load, *Fig.* 5. Travel of the pin against the spring is confined to a distance which automatically provides a clearance of 0.015 to 0.020-inch between the lining and housing when the brakes are released. Thus no service adjustment is required for the life of the lining.

Self-energization of the disk brake is obtained by utilizing the friction forces which tend to rotate the pressure plates in the direction of housing rotation. When contact is established between the pressure plate linings and the brake housing, the rotating housing tends to drag the pressure plates around with it. During forward motion of the car, the inner plate is held rigid and only the outer plate is free to rotate a slight amount.

When the car is in reverse, the outer pressure plate becomes the fixed plate on the rear wheels and self-energization is provided by the movement of the inner plate when it contacts the housing. The front wheel brakes are not self energizing in reverse.

Fade is considerably less in the disk brake as compared with the shoe type brake because of its 30 per cent greater lining area and superior heat transfer and cooling properties. Greater reserve is obtained because the critical distortion of the housing is across its width parallel to its axis rather than along its periphery.

Steel-Weld FABRICATION

This 24 inch main pivot journal bearing, formerly produced in casting form, was redesigned by Mahon engineers for Steel-Weld Fabrication. It is typical of thousands of heavy machinery parts and assemblies produced by Mahon for manufacturers throughout the country. Whatever your requirements may be, regardless of size or weight, you will find in the Mahon organization an unusual source for welded steel in any form . . . a source with complete machining facilities, and a staff of design engineers and craftsmen from whom you may expect a smoother, finer appearing job, embodying every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY
DETROIT 11, MICHIGAN

Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON

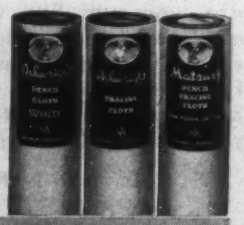
Just Remember the Buy-Word in—

Yes, Arkwright has long been the buy-word for permanence in drawings. Unlike tracing paper, it does not crack and tatter with repeated use—nor become opaque and brittle with time as a file reference record. There are six big reasons why Arkwright Tracing Cloth is the better buy for *any* drawing that may be needed later. Keep a supply ready—it's a paying investment!

Send for generous working samples of Arkwright and see how amazingly it passes the critical tests of fine draftsmanship. Arkwright is sold by leading drawing material dealers everywhere. Arkwright Finishing Co., Providence, R. I.

The Big Six Reasons Why Arkwright Tracing Cloths Excel

1. Erasures re-ink without feathering.
2. Prints are always sharp and clean.
3. Tracings never discolor or go brittle.
4. No surface oils, soaps or waxes to dry out.
5. No pinholes or thick threads.
6. Mechanical processing creates permanent transparency.



ARKWRIGHT
TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 25 YEARS

NEWS
OF MANUFACTURERS

Completion of a new factory at Jackson, Mich., has been announced by the **Clark Equipment Co.**, manufacturers of materials handling, automotive and street railway transportation equipment. This plant represents the major undertaking in the company's overall expansion program and will house the facilities for the production of the Clark line of transmissions, farm tractor drives, gears and forgings. The company also operates plants at Buchanan, Battle Creek and Berrien Springs, Mich.

♦

A new plant for the production of sheet and plate magnesium is to be built in the Detroit area by the newly-formed **Wrought Magnesium Corp.**, subsidiary of **Brooks & Perkins Inc.**, Detroit, Mich. The 40,000 sq ft plant will be completed and in production within a year.

♦

Russell Mfg. Co., Middletown, Conn., has announced that negotiations are under way for opening a branch plant in Bennettsville, S. C., about Jan. 1, 1950. If plans materialize, a 54,000 sq ft building will be built to be operated by a subsidiary known as **Russell Products Co.** on a long-term lease with option to purchase. Russell manufactures brake lining and clutch facings, transmission and conveyor belting, elastic and non-elastic fabrics and aero products.

♦

Tinnerman Products Inc. will build a new plant on Brookpark Rd., Brooklyn Village, Cleveland, O., at a cost of approximately $1,500,000. The Sam W. Emerson Co. has been contracted to build; completion is expected by June, 1950.

♦

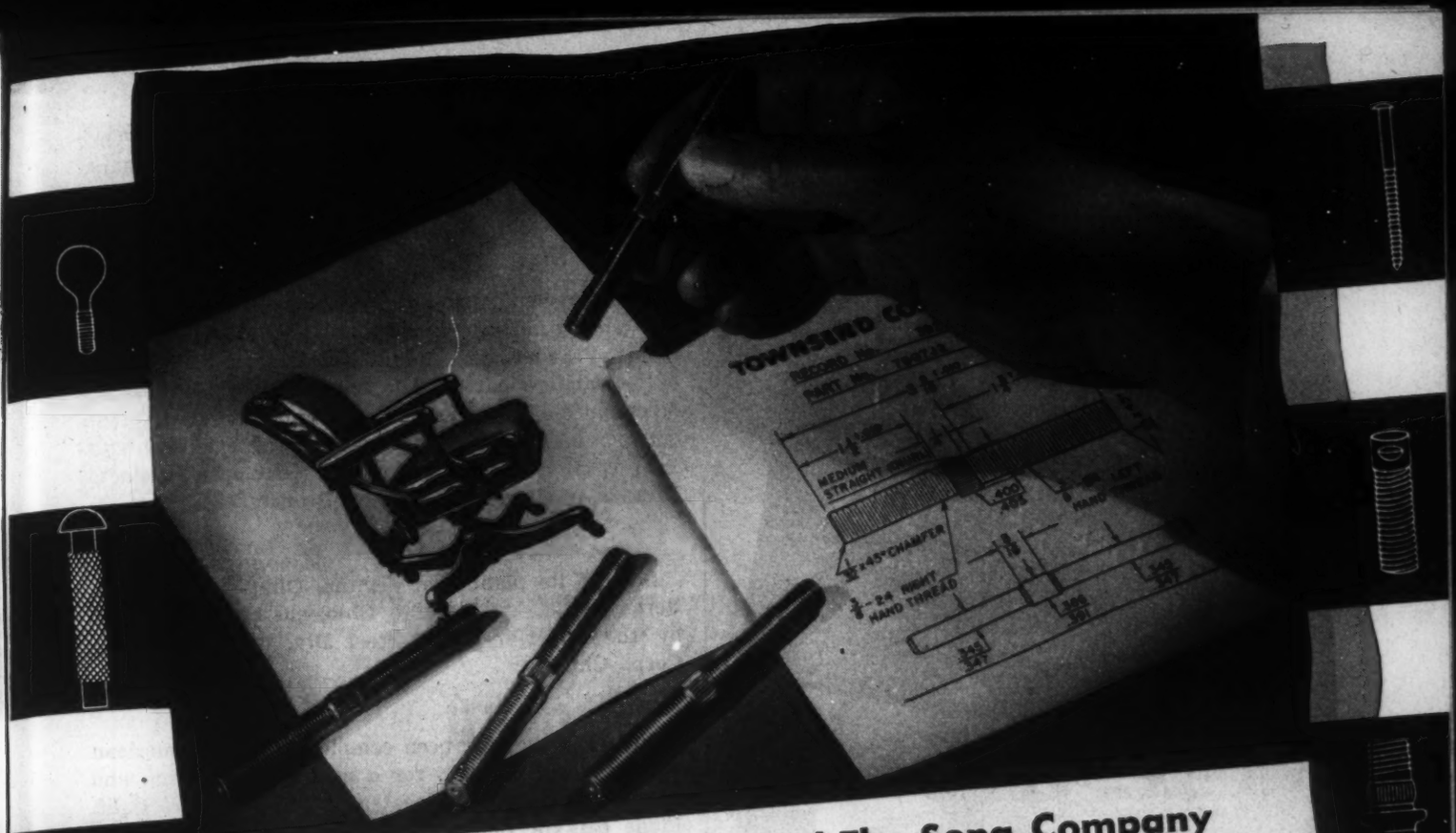
The **F. W. Stewart Mfg. Corp.**, Chicago, Ill., has taken over the **Flex-O-Shaft Sales Co.**, and is now the manufacturer and sole owner of Flex-O-Shaft and Flex-O-Shaft Tool Kit.

♦

A new corporation, **Mid-States Welder Mfg. Co.**, Chicago, has been formed to take over the manufacture of the lines of welding equipment formerly produced by the **Mid-States Equipment Corp.**

♦

The **V & O Press Co.**, Hudson, New York, a division of the **Rockwell Mfg. Co.**, has announced the purchase of the patents, patterns, tools, and other equipment, together with the inventory and all assets, of a punch press feeding device known as Feed-O-



Here's How Townsend Saved The Seng Company $27.63 Per Thousand On One Cold Headed Part

This is an example of how a Chicago manufacturer, *who might have been you,* saved a large amount of money through the use of a Townsend cold headed part and thereby produced a better product for less money. The threaded adjusting screw (illustrated above) for the tilt back of the Seng action control for executive chairs is now being produced at Townsend by cold heading, knurling and roll threading for only $16.87 per thousand. The lowest price quoted for screw machine production was $44.50. This clear saving of $27.63 per thousand is important because Seng chair action control production is extremely high. Not only that, the Townsend part, being cold formed, is stronger than a part machined from bar stock and the roll threads are tougher and more uniform than machined threads. This gives The Seng Company an adjustment screw that works easily and helps produce a better chair at less cost.

This is not an isolated case with Townsend engineered parts and fasteners. It is typical of how Townsend helps save money and time by working closely with manufacturers in designing parts for many applications. Townsend parts and fasteners are cold headed, pointed, machined, drilled, slotted, trimmed, roll threaded, extruded, pierced, knurled, bent or flattened. They are produced in carbon, alloy and stainless steels—in brass, bronze, copper, aluminum—in a variety of platings and finishes.

To find out how to reduce costs and improve your products with Townsend cold headed parts send us a sample or sketch of the parts you need. Our engineers will gladly give you an estimate without obligation.

Call or write today to:

Townsend

COMPANY — ESTABLISHED 1816

New Brighton, Pa.

Chicago 38, Ill.

Need a Hose that can take it?

International Harvester assures dependable transmission of hydraulic power in its "Farmall" tractor through Resistoflex assemblies. Above, Resistoflex assemblies power the hydraulically operated implements.

You won't find many applications tougher on flexible hose than a farm implement. Yet, despite the constant movement, vibration and exposure, Resistoflex assemblies don't quit. These top grade lines keep hydraulic circuits functioning at full efficiency—keep a machine on the go. Any time you assure that kind of service, you can take customer satisfaction for granted.

Chances are that Resistoflex lines can do an outstanding job for you, too. Not only are they completely unaffected by flexing and vibration, but they're really impervious to hydraulic fluids and oils too. You run no risk of clogged mechanisms with this non-eroding hose.

Learn more about why Resistoflex lines insure against excessive replacements and service complaints. Write us about your flexible line problem *today*.

RESISTOFLEX
CORPORATION

Belleville 9, New Jersey

SYNTHETIC FLEXIBLE PRODUCTS AND PARTS FOR INDUSTRY

Matic, from the **Covert Mfg. Co.**, Troy, N. Y. The device will be built at the V & O Press Co. plant and will be sold through representative sales organizations.

♦

The **Cleveland Graphite Bronze Co.** has announced the acquisition of the business and assets of **Monmouth Products Co.**, manufacturers and distributors of automotive parts. The business will continue to be conducted by its present personnel and in its present location, two buildings at 6545 Carnegie Ave. and 1931 E. 61 St., Cleveland, as the Monmouth Products Division of Cleveland Graphite Bronze.

♦

Sale of its plant near Canton, Ohio, to **The Louis Berkman Co.**, Steubenville, Ohio, has been announced by the **Superior Sheet Steel Div.** of **Borg-Warner Corp.**, Chicago.

♦

Negotiations have been completed by the **American Blower Corp.**, Detroit, for a new manufacturing and assembly plant to be located at San Leandro, Calif. Plans call for the erection of a single masonry and steel building, covering 40,000 sq ft, to be ready for operation in January, 1950.

♦

An expansion program totaling $125,000 has been announced by the **Plastic & Rubber Products Inc.**, Dayton, Ohio, manufacturers of "O" ring hydraulic seals. The program calls for a 16 by 30-ft two-story addition to the general office and a 40 by 60-ft two-story addition complete with electrically heated rubber presses. Work on the buildings and the installation of the machinery are to be completed by Dec. 1, 1949.

♦

The Russell Mfg. Co., Middletown, Conn., has purchased the **Howard Asbestos Co.**, Northfield, Vt. Purchase will insure a supply of asbestos yarns for the company's automotive friction materials known as Rusco brake linings and clutch facings.

♦

Parker Mfg. Co., Worcester, Mass., has acquired **Ackermann-Steffan Co.**, Chicago, Ill., manufacturers of Trojan Brand coping, jig, power machine and jewelers' saw blades, and coping, jewelers', scroll and hack saw frames. The Chicago firm will be known as the Ackermann-Steffan Div. of Parker Mfg. Co.

♦

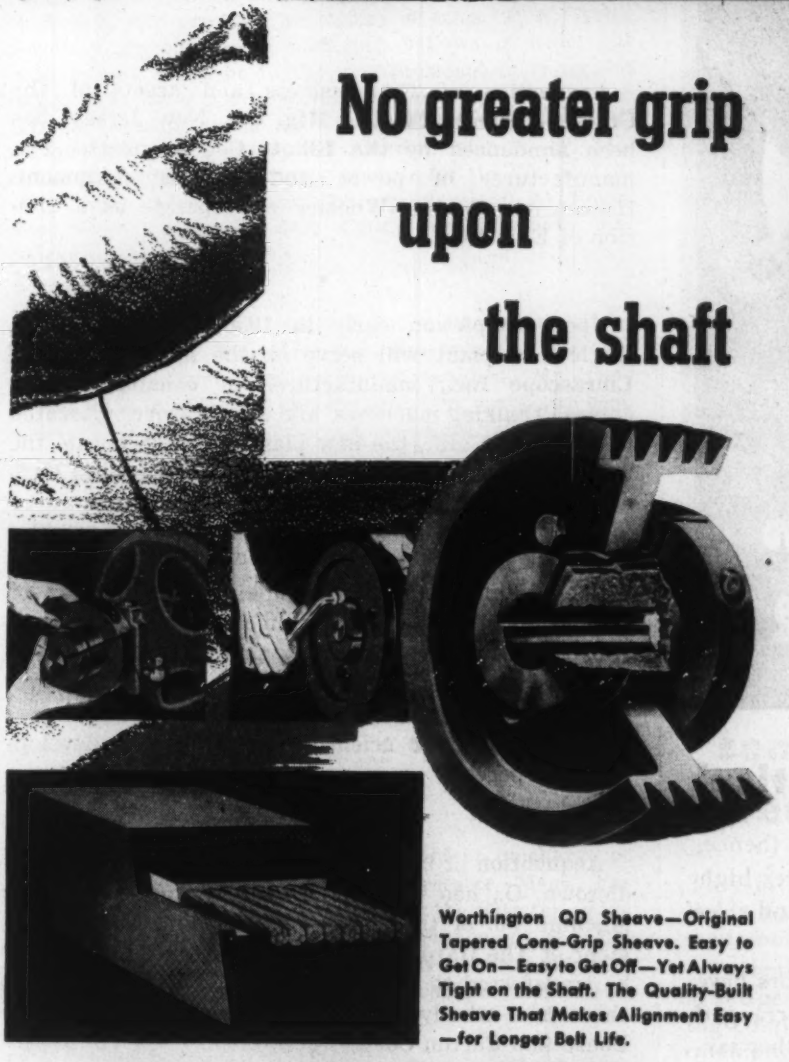
Integration of the **Lycoming-Spencer Div.** of **Avco Mfg. Corp.** into a single operating unit has been announced. Formerly, the Lycoming and Spencer Heater Divisions operated as individual units.

♦

Acquisition of the **Hisey-Wolf Machine Co.**, manufacturer of industrial grinding machines, and buffing and polishing lathes, has been announced by **The Cin-**

THE GOOD RIGHT HAND OF INDUSTRY

No greater grip upon the shaft



Worthington QD Sheave—Original Tapered Cone-Grip Sheave. Easy to Get On—Easy to Get Off—Yet Always Tight on the Shaft. The Quality-Built Sheave That Makes Alignment Easy —for Longer Belt Life.

The original tapered cone-grip of the two-piece QD Sheave produces a tighter fit on the shaft *than any other sheave.*

The tapered-bore rim, pulled up on the tapered-cone hub, causes a cone friction grip of rim on hub; and, in turn, a positive press fit on the shaft.

Yet no sheave is as easy to put on and get off. Positioning the hub first saves juggling a heavy rim—the rim slides easily over the hub and is pulled up by the full-sized bolts. The same bolts are used as jack screws to loosen the rim for dismounting—and the hub stays put in permanent adjustment.

For Balanced Drive Performance

Specify Worthington Multi-V-Drives, with QD Sheaves and Worthington-Goodyear EC V-Belts. Each strand in the belt carries its equal share of the belt load, as each belt carries its full share of the drive load. (Goodyear EC Cord or Steel Cable V-Belts are used exclusively in Worthington Multi-V-Drives.)

Complete Range of Stock Sizes—Prompt Shipment

853 listed stock sizes in "A", "B", "C", and "D" sections, fhp to 200 hp . . . 332 listed stock sizes of EC Cord V-belts. Send coupon for latest Worthington QD Sheave bulletin.

WORTHINGTON

WORTHINGTON PUMP AND MACHINERY CORPORATION
MULTI-V-DRIVE SALES DIVISION
Buffalo, New York • General Offices: Harrison, New Jersey

The Good Right Hand of Industry

POWER TRANSMISSION: sheaves, V-belts, variable speed drives
PUMPS: centrifugal, power, rotary, steam
MVD-1 AIR COMPRESSORS: water-cooled, air-cooled

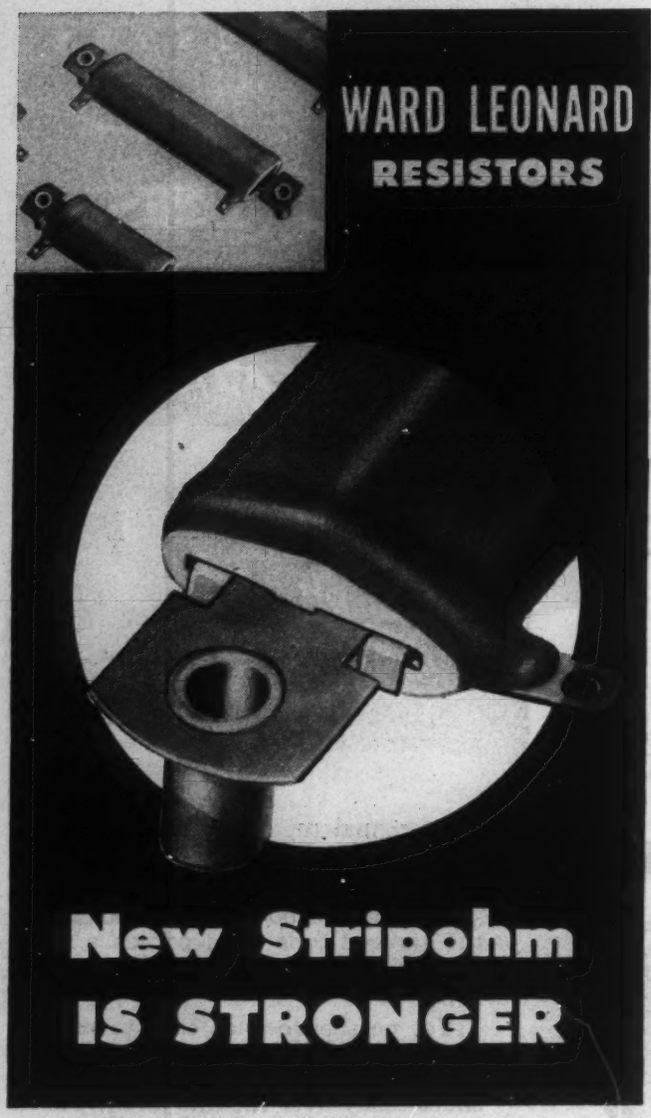
Worthington Pump & Machinery Corporation
Multi-V-Drive Sales Division, Dept. MVA99
Buffalo, N. Y.
Send latest bulletin on Worthington Multi-V-Drives.

Name.....

Company.....

Address.....

MVD-2



because the shape is elliptical

When space is at a premium, the elliptical (hence, stronger) shape of STRIPOHM Resistors gives high unit-space rating and extra strength to withstand electrical and mechanical strain.

These vitreous enameled wire-wound resistors have low mounting brackets . . . strategically arranged terminals permitting multiple stacking for further saving of space . . . no sharp edges. Ratings from 30 to 75 watts . . . 0.45 to 66,000 ohms.

Write for Bulletin 23. WARD LEONARD ELECTRIC COMPANY, 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY
Result-Engineered Controls
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

cinnati Electrical Tool Co. Production of the Hicey-Wolf line of more than 200 models will continue under the old trade name in the plant of the new owners.

♦

Seven small Connecticut tool and die and contract manufacturing shops with assets of more than $1 million have joined to set up a new corporation to be known as the **Connecticut Mechanical Industries Inc.** With headquarters at 390 Capitol Ave., Hartford, Conn., the new corporation represents facilities which include over 90,000 sq ft of floor space, 625 machine tools and several hundred skilled craftsmen.

♦

Acquisition of the business and assets of the **Crocker-Wheeler Electric Mfg. Co.**, New Jersey, has been announced by the **Elliott Co.**, Jeannette, Pa., manufacturer of power and process equipment. Henceforth, Crocker-Wheeler will operate as a division of Elliott Co.

♦

Upon completion early in 1950, a 50,000 sq ft, single-deck plant will serve as the headquarters of **Librascope Inc.**, manufacturer of calculating machines, 'thinking machines' and allied devices. Located in Glendale, Calif., the new plant will incorporate the facilities now operating in two smaller plants in Burbank and Glendale.

♦

Foote Mineral Co., Philadelphia, manufacturer of lithium, strontium, and tungsten chemicals; metals and alloys, electrode coating materials and refined ores, has purchased the Easttown School building, Berwyn, Pa. Plans are under way for conversion of the three-story building for scientific research and development purposes.

♦

Acquisition of the assets of **Bevis Machine Co.**, Middletown, O., has been announced by **The Manchester Machine Co.** of the same city. Machine shop equipment of **The Gardner Board and Carton Co.** is also to be transferred to the latter's plant. Manchester Machine is a wholly-owned subsidiary of The Gardner Board and Carton Co.

♦

Randall Graphite Bearings Inc. has purchased the foundry and machine shop of **Shook Bronze Corp.**, Lima, O. The foundry was modernized in 1946; the machine shop will be augmented by the transfer of the Randall Chicago plant to Lima. The Lima plant will be known as Randall Graphite Bearings Inc., Shook Bronze Division.

♦

Correction: In the September issue, the **Rollins Engine & Machine Co. Inc.**, newly formed subsidiary of the **A. S. Campbell Co. Inc.**, Boston, was erroneously listed as the Rinns Engine & Machine Co. Inc.

SALES AND SERVICE PERSONNEL

MANUFACTURERS of expansion joints for piping systems, stainless steel and brass bellows and flexible metal hose, Chicago Metal Hose Corp., Maywood, Ill., has announced several organizational changes: **Shelby A. McMillion** has been appointed assistant to **A. S. Keller,** vice president in charge of sales; **T. K. Wells,** formerly regional sales manager, bellows division, has been named assistant to the vice president in charge of sales; **E. L. Hiter** has been made manager of sales for the Eastern division, including offices in Boston, New York, Philadelphia, Pittsburgh and Atlanta; and **A. W. McGuire** was appointed manager of sales for the Western division, with sales offices in Detroit, Cleveland, St. Louis, Fort Worth, Tex., Glendale, Calif., San Francisco, and Chicago.

♦

Newly appointed manager of the industrial sales department of SKF Industries Inc., **Emerson D. Ogle** succeeds **C. D. Cummings,** who has resigned. Mr. Ogle joined SKF in 1937 and for the last two years has been manager of the automotive and electrical section of the industrial department.

♦

Philip T. Coffin has been named manager of pig and ingot sales and manager of the warehousing division for Aluminum Co. of America. He joined Aloca in 1926 as a cable salesman, served as works manager for the Alcoa-operated government-owned aluminum plant at Queens, N. Y., during World War II, and was made assistant manager of the company's New York district sales office in 1945. Mr. Coffin succeeds **Hugo T. Wilder,** who was recently made manager of the company's newly created marketing division.

♦

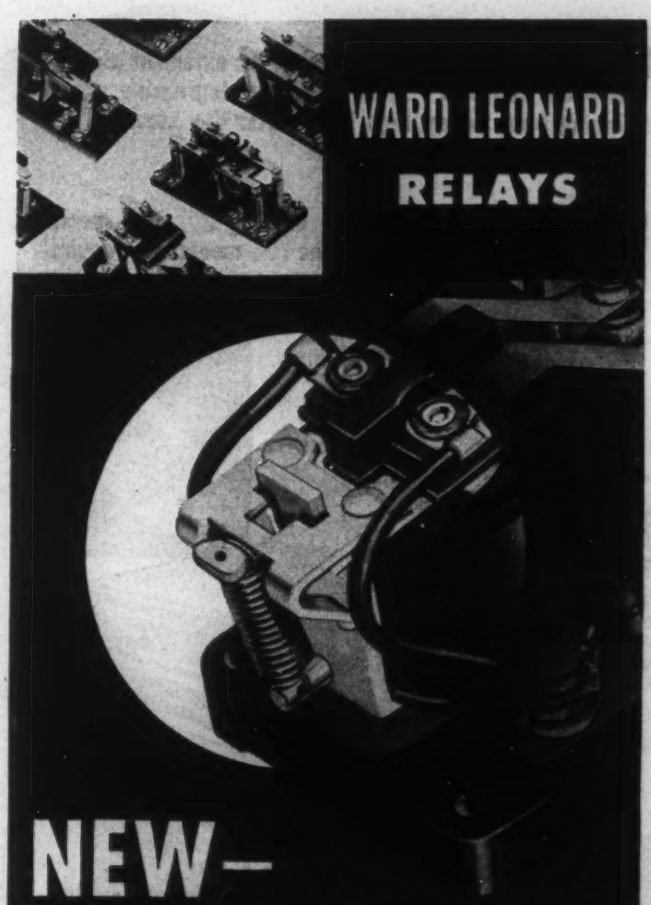
The newly created post of vice president in charge of sales for Graton & Knight Co., Worcester, Mass., has been filled by **Elliott C. Paddock.** For the past ten years Mr. Paddock has been general sales manager of the Corbin Screw division, American Hardware Corp. and prior to that was field sales manager in charge of domestic sales for Greenfield Tap and Die Corp.

♦

Farrel-Birmingham Co. has announced the appointment of **David Neill** as Cincinnati sales representative for gears, gear units and flexible couplings manufactured in the company's Buffalo plant. He joined Farrel-Birmingham's sales department in 1945, after spending three years in the company's gear manufacturing division.

♦

Recently named industrial sales manager of the Cincinnati branch office of Brown Instruments division, Minneapolis-Honeywell Regulator Co., **Charles D. McIntire** succeeds **George Brown,** who has been assigned to promotion of products of the company's Belfield valve division. Mr. Brown's headquarters will be in Cleveland. At the same time it was announced that **John E. MacConville** has been made industrial sales man-



semi-knife-edge bearing reduces frictional wear

This is Ward Leonard's new Bulletin 110 Midget Relay for long, trouble-free service, particularly in equipments subject to vibration.

Exceptionally good vibration characteristics are due to proper proportioning of contact masses and springing combined with heavy pressures on both normally open and normally closed contacts.

Higher contact ratings than most midgets. Available up to 3-pole, double throw. Contact finger leads are insulated with the new, impregnated glass-fiber tubing.

Write for Bulletin 110. Ward Leonard Electric Co., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY
Result-Engineered Controls
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

PROBLEM: Outboard bearings on extended pin roller chain conveyor . . . to withstand degreasing vapor, dipping bath fumes, high heat, water dip, steam, phosphoric acid spray.

SOLUTION: A Morganite bearing . . . the special bearing for special conditions . . . meets all requirements . . . is entirely self-lubricating under all conditions.

SELF-LUBRICATING MORGANITE OUTBOARD BEARINGS ON CONVEYOR BELT ROLLER CHAIN

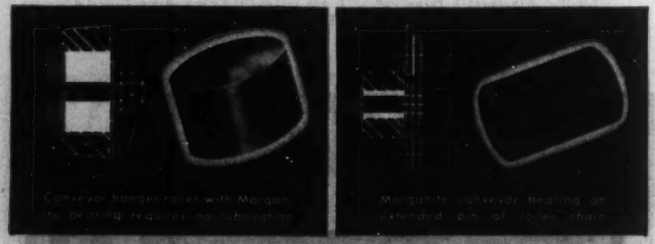
MORGANITE
SELF-LUBRICATING
CARBON BEARINGS

One application that clearly demonstrates the special properties of Morganite bearings is their use on conveyor belts involving continuous changes of atmosphere and temperature. Bearings, pump blades and seal rings of Morganite easily withstand these conditions . . . actually operate better when submerged in liquids. They are immune to oil, petroleum, water, brine, most acids and alkalies. Being self-lubricating they do not contaminate contacting liquids and materials with grease or oil, impart no odor or taste.

See our CATALOG in SWEET'S FILE

Additional data on Morganite will be found in Sweet's File for Product Designers. For competent engineering help on specific problems consult a Morganite sales engineer. There is no obligation.

REGISTERED TRADE MARK Morganite INCORPORATED
LONG ISLAND CITY 1, NEW YORK



Manufacturers of Morganite Carbon Brushes for all motor and generator applications, and Morganite Carbon Piles.

ager of the Atlanta branch office. He will also supervise industrial sales activities in the Birmingham, Ala., Jacksonville, Fla., and Knoxville, Tenn. offices. **William C. Waltman** has been placed in charge of industrial sales in the South Bend, Ind. office, succeeding **George Gilliam**, who will supervise all pyrometer supplies sales for the company.

♦

Associated since 1925 with the Pittsburgh Plate Glass Co. plant division at Newark, N. J., **J. T. Murnane** has been appointed industrial sales manager of the division.

♦

The Electric Products Co., 1725 Clarkstone Rd., Cleveland 12, O., has appointed **E. G. Schroeder** to the position of field sales manager, supervising all district sales activities. Mr. Schroeder brings to his new position experience in electrical sales and engineering gained by a year with the New York State Electric and Gas Corp. and over seven years with the General Electric Co. He joined the Electric Products Co. in 1945 to manage their Detroit district office.

♦

Timothy Grace has become a member of the sales staff of Slawson Equipment Co. Inc., 1792 East 40th St., Cleveland, O. He will specialize in the sale and application of all types of heating, cooling coils, industrial fans and heat transfer products.

♦

New Midwestern sales representative of the Plastic Metals division of the National Radiator Co., Johnstown, Pa., **E. Richard Walter** will be in charge of sales of metal powders in Ohio, Michigan, Indiana, Illinois, Missouri, Iowa, Wisconsin, and Minnesota. His headquarters are in the Daily News Bldg., 400 West Madison St., Chicago 6, Ill. The division produces iron powder and other ferrous and non-ferrous metal powders used largely in the fields of powder metallurgy, electronics and chemistry.

♦

The appointment of **Kenneth H. MacWatt** as director of engineering sales has been announced by L. O. Koven and Brother Inc., Jersey City, N. J., manufacturers of boilers, tanks, special process equipment and weldments.

♦

Precision Metalsmiths Inc., 6511 Cedar Ave., Cleveland, O., has promoted **R. A. J. Wellington** to the position of national sales manager. Mr. Wellington assumes direction of twelve representatives located in industrial areas throughout the nation. He has had six years' experience in the precision metalcasting field, including three and one-half years in charge of Precision Metalsmith's home-office sales since the organization of the company.

♦

Succeeding **J. M. Taylor**, who has resigned, **John G. Benjamin** has been appointed sales manager of the Abbott Ball Co., Hartford 10, Conn. Mr. Benjamin will be in charge of sales for both the Bearing Ball and burnishing divisions.

♦

Formerly manager of the Buffalo territory for Charles H. Besly & Co., **E. O. Howard** has been appointed sales engineer for the Grinder and Titan Abrasive divisions of the company.

Welded Steel
FABRICATION

Mill Drive Case and Cover. Case, 20' x 9' x 8'8". Cover, 17'6" x 6'7" x5'.

NO WELDMENT TOO LARGE OR TOO SMALL

for economical design and fabrication by GRAVER

FROM *60,000* POUNDS

TO *600* POUNDS

End Housing for a Diesel Engine. Stress relieved. 4' x 3'.

Size—large or small—is no limitation to Graver designers and welders in the fabrication of welded steel structures. They have at their disposal years of experience and complete shop facilities . . . a necessity if the advantages inherent in welded fabrication are to be exploited to their fullest extent in the finished product. Graver weldments are built either to your own drawings and specifications or to designs developed by the Graver Engineering Department. All machining operations are available to carry each job to the point of greatest economy for the purchaser. For quotations or assistance in design work, write or wire today.

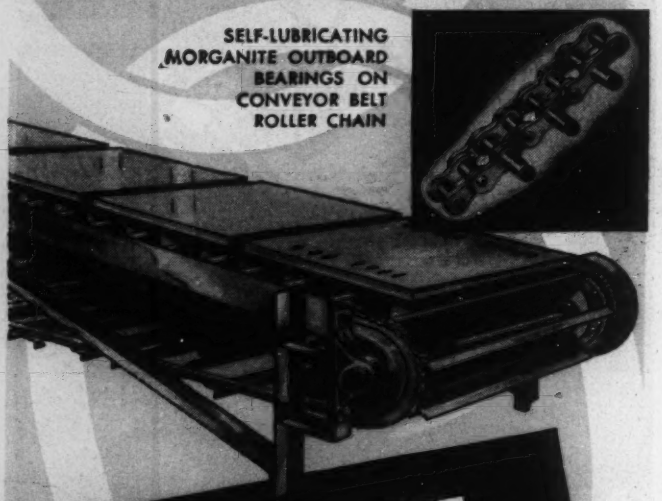
AMERICAN WELDMENT MANUFACTURERS ASSOCIATION · AWMA

WELDMENT DIVISION

GRAVER

PROBLEM: Outboard bearings on extended pin roller chain conveyor . . . to withstand degreasing vapor, dipping bath fumes, high heat, water dip, steam, phosphoric acid spray.

SOLUTION: A Morganite bearing . . . the special bearing for special conditions . . . meets all requirements . . . is entirely self-lubricating under all conditions.



MORGANITE
SELF-LUBRICATING
CARBON BEARINGS

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REGISTERED TRADE MARK Morganite INCORPORATED
LONG ISLAND CITY 1, NEW YORK

Manufacturers of Morganite Carbon Brushes for all motor and generator applications, and Morganite Carbon Piles.

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Timothy Grace has become a member of the sales staff of Slawson Equipment Co. Inc., 1792 East 40th St., Cleveland, O. He will specialize in the sale and application of all types of heating, cooling coils, industrial fans and heat transfer products.

♦

New Midwestern sales representative of the Plastic Metals division of the National Radiator Co., Johnstown, Pa., **E. Richard Walter** will be in charge of sales of metal powders in Ohio, Michigan, Indiana, Illinois, Missouri, Iowa, Wisconsin, and Minnesota. His headquarters are in the Daily News Bldg., 400 West Madison St., Chicago 6, Ill. The division produces iron powder and other ferrous and non-ferrous metal powders used largely in the fields of powder metallurgy, electronics and chemistry.

♦

The appointment of **Kenneth H. MacWatt** as director of engineering sales has been announced by L. O. Koven and Brother Inc., Jersey City, N. J., manufacturers of boilers, tanks, special process equipment and weldments.

♦

Precision Metalsmiths Inc., 6511 Cedar Ave., Cleveland, O., has promoted **R. A. J. Wellington** to the position of national sales manager. Mr. Wellington assumes direction of twelve representatives located in industrial areas throughout the nation. He has had six years' experience in the precision metalcasting field, including three and one-half years in charge of Precision Metalsmith's home-office sales since the organization of the company.

♦

Succeeding **J. M. Taylor,** who has resigned, **John G. Benjamin** has been appointed sales manager of the Abbott Ball Co., Hartford 10, Conn. Mr. Benjamin will be in charge of sales for both the Bearing Ball and burnishing divisions.

♦

Formerly manager of the Buffalo territory for Charles H. Besly & Co., **E. O. Howard** has been appointed sales engineer for the Grinder and Titan Abrasive divisions of the company.

Welded Steel
FABRICATION

Mill Drive Case and Cover. Case, 20' x 9' x 8'8". Cover, 17'6" x 6'7" x5'.

FROM *60,000* POUNDS

TO *600* POUNDS

End Housing for a Diesel Engine. Stress relieved. 4' x 3'.

NO WELDMENT TOO LARGE OR TOO SMALL

for economical design and fabrication by GRAVER

Size—large or small—is no limitation to Graver designers and welders in the fabrication of welded steel structures. They have at their disposal years of experience and complete shop facilities . . . a necessity if the advantages inherent in welded fabrication are to be exploited to their fullest extent in the finished product. Graver weldments are built either to your own drawings and specifications or to designs developed by the Graver Engineering Department. All machining operations are available to carry each job to the point of greatest economy for the purchaser. For quotations or assistance in design work, write or wire today.

MEMBER AMERICAN WELDMENT MANUFACTURERS ASSOCIATION · AWMA

WELDMENT DIVISION

GRAVER

YES, Ace hard rubber literally knocked the stuffings out of the arm for this chair. Formerly a padded, upholstered metal stamping bolted to the chair frame, it's now a one-piece, indestructible hard rubber molding, with leather-grain finish, and a feel that's just right.

What's more, it's assembled to the chair in a jiffy. You simply slide a headed insert into a slot, flex the rubber around the curve, and run up two screws from underneath.

You too may find "a better way" in one of the many Ace hard rubber or plastics molding and extruding compounds.

If you would like to know more about these Ace materials—where used—properties—design hints, etc., just write on your company letterhead for the new free 60-page Ace Handbook.

ACE
HARD RUBBER and OTHER IMPORTANT PLASTICS
AMERICAN HARD RUBBER COMPANY
11 MERCER STREET • NEW YORK 13, N. Y.

SALES NOTES

NEW DISTRIBUTORSHIPS in the St. Louis and Minneapolis territories have been announced recently by **Plastic & Rubber Products Inc.**, Dayton, O. **Associated Rubber Products Co.** was appointed distributor in St. Louis, and the **Miller Rubber Sales Co.** is now distributor in the twin cities and surrounding area. Both will carry in stock, for immediate delivery, a wide assortment of O-ring seal sizes.

♦

The firm of **Cole-Schreiber,** 4702 Hayvenhurst Dr., Encino, Calif., has been appointed representative for magnesium alloy sand castings for the **Hills-McCanna Co.,** 3025 North Western Ave., Chicago, Ill.

♦

Recently announcement was made of the appointment of **John D. Tebben Co.,** 20869 Mound Rd., Detroit, Mich., as sales representative of **Gibson Electric Co.,** Pittsburgh manufacturers of electrical contacts and electrical contact assemblies. The Tebben company's territory includes the state of Michigan and Toledo, O.

♦

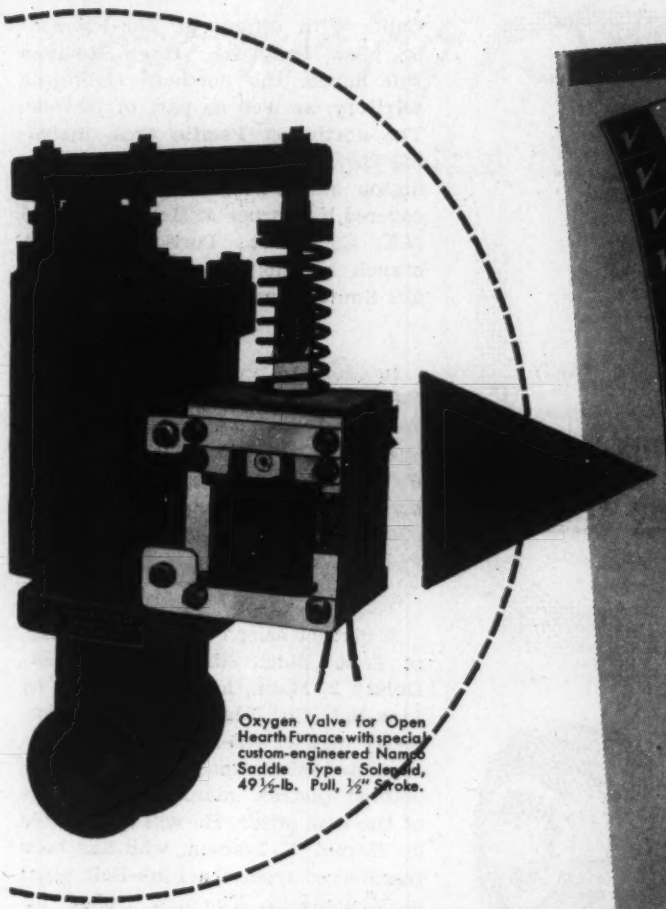
According to a recent announcement, the name of General Time Instruments Corp. has been changed to **General Time Corp.** The address of the company remains 109 Lafayette St., New York 13, N. Y.

♦

The **Cooper Alloy Foundry Co.** of Hillside, N. J. has appointed **Wm. G. Boales & Associates** of Detroit as their Michigan representative. The addition of the Cooper line of stainless steel valves, fittings, accessories and engineered castings to the Wm. G. Boales line of products will make possible faster and more direct service to customers.

♦

In order to strengthen its distributor organization throughout the country, **Kieley & Mueller Inc.** of North Bergen, N. J. has appointed three new sales representatives in the West. Sales in southern California and Arizona will be under the direction of the **W. J. Beckett Co.,** 108 West Sixth St., Los Angeles,



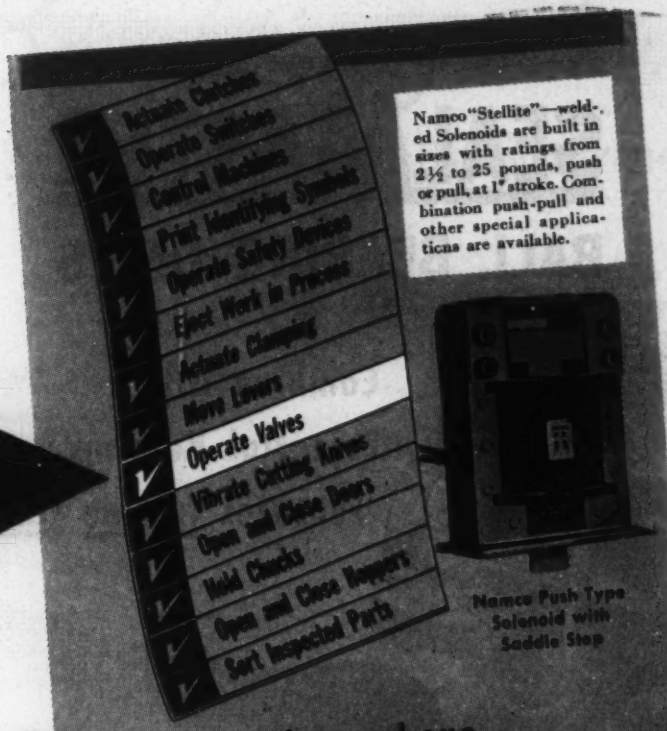
Oxygen Valve for Open Hearth Furnace with special custom-engineered Namco Saddle Type Solenoid, 49½-lb. Pull, ½" Stroke.

"...owing to the safety requirements in this application, we were interested only in the best solenoid that could be obtained".

Straight from our own check list comes this success story, typical of the many exacting applications Namco Solenoids are handling.

This valve is specially designed to handle an intermittent supply of oxygen, fed into open hearth furnaces at 150-lb. pressure. In addition to normal operation requirements, the valve closes automatically upon power failure; solenoid has 116-lb. holding force when valve is closed. Customer says, "Solenoid is doing a very fine job of controlling a very difficult and dangerous gas."

Write for full information on the complete range of Namco Solenoids—Bulletin EM46A.



If you have jobs like these then you need SOLENOIDS

They're the modern, up-to-date way of doing jobs automatically—by remote control, and in cramped quarters if necessary.

With the positive, accurate action of Solenoids you can simplify design, manufacture and operation. They're taking the place of expensive, bulky gear trains, levers, linkages and other mechanisms. Many a manufacturer has come to us with a cost or space problem—and has found the solution in Namco Solenoids.

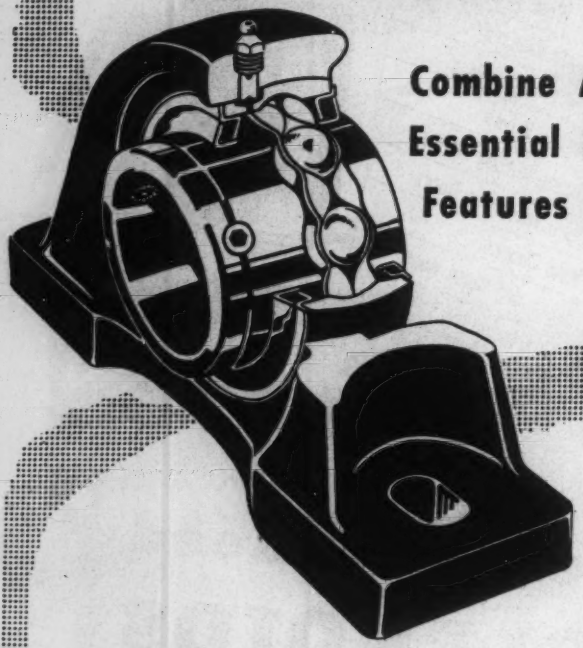
Namco Solenoids—with "Stellite"—welded contacts, are compact, rugged and reliable. They're *engineered* to the requirements of the job with the aid of an *expert*. That's where we can help you. We'll be glad to recommend the size and style best suited to your job—with standard or special terminal blocks and mountings. Like more details? Ask for bulletin EM-46A.

ELECTRICAL MANUFACTURING DIVISION

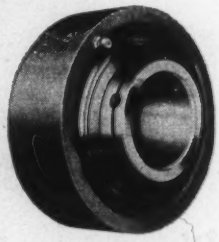
NATIONAL ACME

CLEVELAND, OHIO

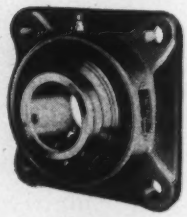
SEALMASTER
BALL BEARING UNITS



Combine All Essential Bearing Features In One Unit!



Cartridge Units



Flange Units

Flange Cartridge Units

SEALMASTER Ball Bearing Units have features that contribute to the good performance and long life of any industrial product on which they are used. Textile equipment, oil field machinery, farm implements and air conditioning equipment are only a few of the many widely varied fields in which manufacturers have standardized on SEALMASTER units. To be sure of the best possible bearing performance, consider SEALMASTER units when designing, or redesigning products. Write us for a copy of SEALMASTER Catalog No. 845.

Here is the exclusive combination of features found only in SEALMASTER Ball Bearing Units:

- **Permanently Sealed** — Felt-lined, steel flinger, rotating in labyrinth, keeps dirt out and retains lubricant . . . prolongs bearing life.
- **Self-Aligning** — Bearing unit with seals independent of housing can align itself in any direction without seal distortion.
- **Pre-Lubricated** — Bearings are factory lubricated and are shipped ready for immediate use.
- **No Housing Wear** — Patented locking pin prevents rotation of outer race in housing and positions bearing for relubrication . . . no housing wear means quiet operation.

BEARING DIVISION

STEPHEN S-A DAMSON MFG. CO.

18 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Factory Representatives and Dealers in All Principal Cities

Calif. With offices at 270 Fremont St., San Francisco, **Hugh Rodman** will handle the northern California territory, as well as part of Nevada. The northwest Pacific area, including the states of Oregon and Washington and western Idaho, is to be covered by **Farnes & Martig Inc.**, 417 N.E. Couch St., Portland, Ore. A branch of this office is located at 422 Smith Tower, Seattle, Wash.

♦

In order to provide more adequate Eastern market representation, the **Western Foundry Co.** of Chicago has opened a New York office at 527 Fifth Ave. The company manufactures gray iron, semisteel castings and operates commercial pattern and machine shops.

♦

A district sales office at 422 Board of Trade Bldg., 301 West First St., Duluth 2, Minn., has been opened by **Link-Belt Co.** John E. Morrison, formerly district sales engineer at Chicago and Minneapolis, has been appointed district manager in charge of the new office. He will be assisted by Harold A. Ivarson, who has been transferred from the Link-Belt plant in Minneapolis. The new Duluth office was established to better serve the materials handling and power transmission needs of industries, mines and engineers in northeastern Minnesota, northern Wisconsin and the upper peninsula of Michigan.

♦

The **W. P. and R. S. Mars Co.**, 322-324 West Michigan St., Duluth, Minn., has been appointed distributor by **Ampco Metal Inc.**, Milwaukee. The company will handle the complete line of Ampco welding electrodes in northern Minnesota, the upper peninsula of Michigan and northern Wisconsin.

♦

Three branch sales offices of the New Departure division of **General Motors Corp.** have recently moved to new locations. The new addresses in Boston and Indianapolis are 937-A Park Square Bldg., 31 St. James Ave., Boston 16, Mass., and 1357 West Eighteenth St., Indianapolis 2, Ind., and the office formerly in San Francisco has been moved to 1716 Fourth St., Berkeley 10, Calif.

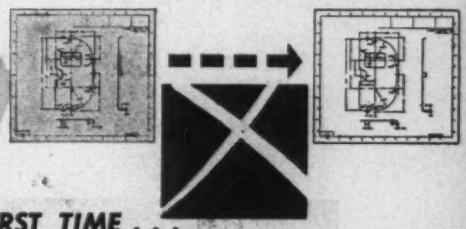
♦

New exclusive sales representative in the northern Ohio district for the **B. C. Ames Co.**, Waltham, Mass., line of micrometer dial indicators and micrometer dial gages is **Hal W. Reynolds Co.**, 2902 Euclid Ave., Cleveland, O.

Introducing... 3 revolutionary advantages

that lower the cost of photographic intermediates

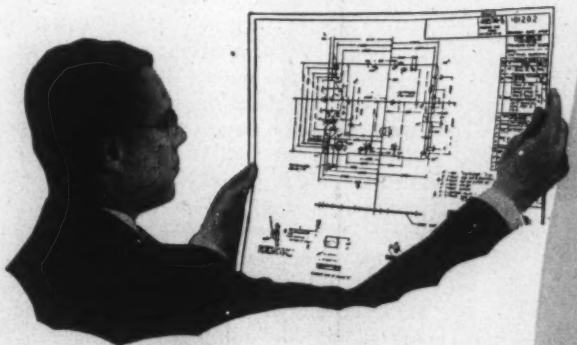
FIRST TIME . . .
you can print a photographic intermediate in your direct process or blueprint machine . . . and develop it in standard photographic solutions. Kodagraph Autopositive Paper brings you this advantage in the reproduction of any drawing or record—whether it be translucent or opaque . . . old or new.



FIRST TIME . . .
you can produce positive photographic intermediates directly from your originals—without a wasteful negative step. The result every time is a print with dense black photographic lines on a clear, non-curling translucent base—an intermediate that produces uniform prints at practical machine speeds . . . that's "photo-lasting" in the files.

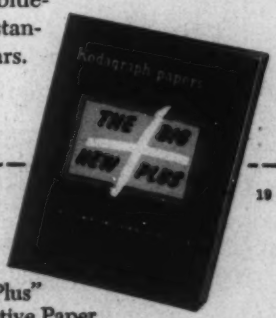
THE BIG NEW PLUS

Kodagraph Autopositive Paper



FIRST TIME . . .
you can handle a photographic intermediate material in ordinary room-light—dispense with the darkroom! And processing is simplified still further because Kodagraph Autopositive Paper has wide latitude . . . is amazingly uniform from sheet to sheet, package to package.

3 revolutionary advantages—you will agree . . . advantages that mean low cost protection for the thousands of dollars you have invested in engineering drawings. Learn all the facts about Kodagraph Autopositive Paper . . . all the reasons why you or your local blueprinter can process it with substantial savings in time, labor, dollars.



Mail coupon for FREE booklet

19

Eastman Kodak Company
Industrial Photographic Division
Rochester 4, N.Y.

Please send me a copy of "The Big New Plus" —your booklet about Kodagraph Autopositive Paper, and the other papers in this new Kodak line. I have
☐ direct process ☐ blueprint ☐ contact printer equipment.

Name_____ (please print)

Department_____

Company_____

Street_____

City_____

State_____

"Kodak" is a trade-mark

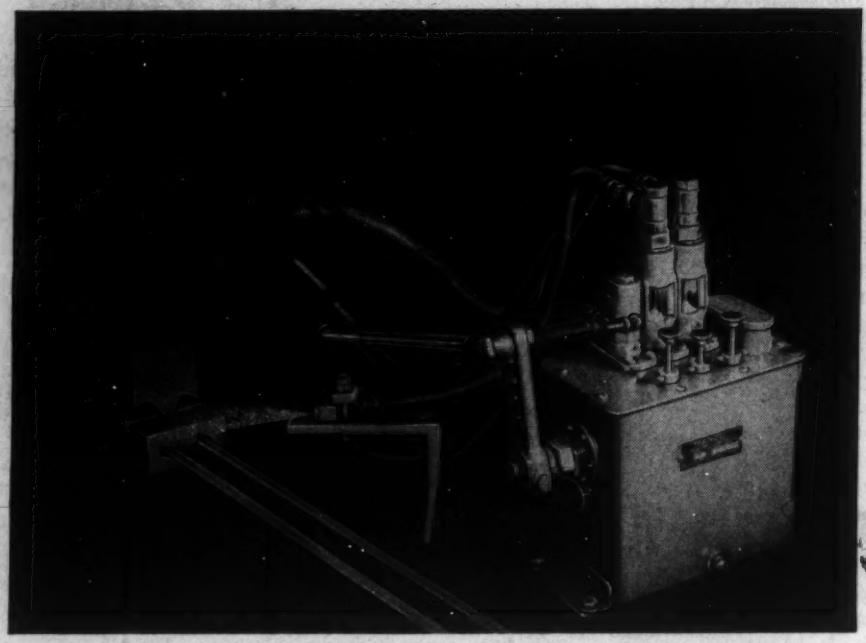
EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.

Kodak

NEW SPRAY LUBRICATION SYSTEM

✔ INCREASES OUTPUT ✔ REDUCES DOWN TIME

✔ LENGTHENS DIE LIFE ✔ CUTS OIL CONSUMPTION



● The new Manzel Spray Lubrication system forces automatically timed jets of oil mist directly onto punches, shear knives, dies, or other parts. Manufacturers who have adopted the system report die life increased as much as 3 times, down time and punch breakage reduced, oil consumption cut to 1/10 as much as in hand swabbing. Savings in the first few months repay the initial cost many times over.

In many operations where proper lubrication presents a problem, the Manzel Spray System may be the solution. It is readily installed on any machinery, and adaptable to both large and small work. Write for descriptive folder.

Manzel

DIVISION OF
FRONTIER INDUSTRIES
Inc.
276 BABCOCK STREET BUFFALO 10, N. Y.

DESIGN ABSTRACTS

Atomic Power for Aircraft

ATOMIC power appears to be an extremely attractive solution if we are to extend the range of aircraft beyond the radius of current or projected craft carrying standard fuels. Our present supersonic airplanes run out of fuel in a matter of a few minutes. With atomic power, they could keep going because the fuel supply would remain nearly constant.

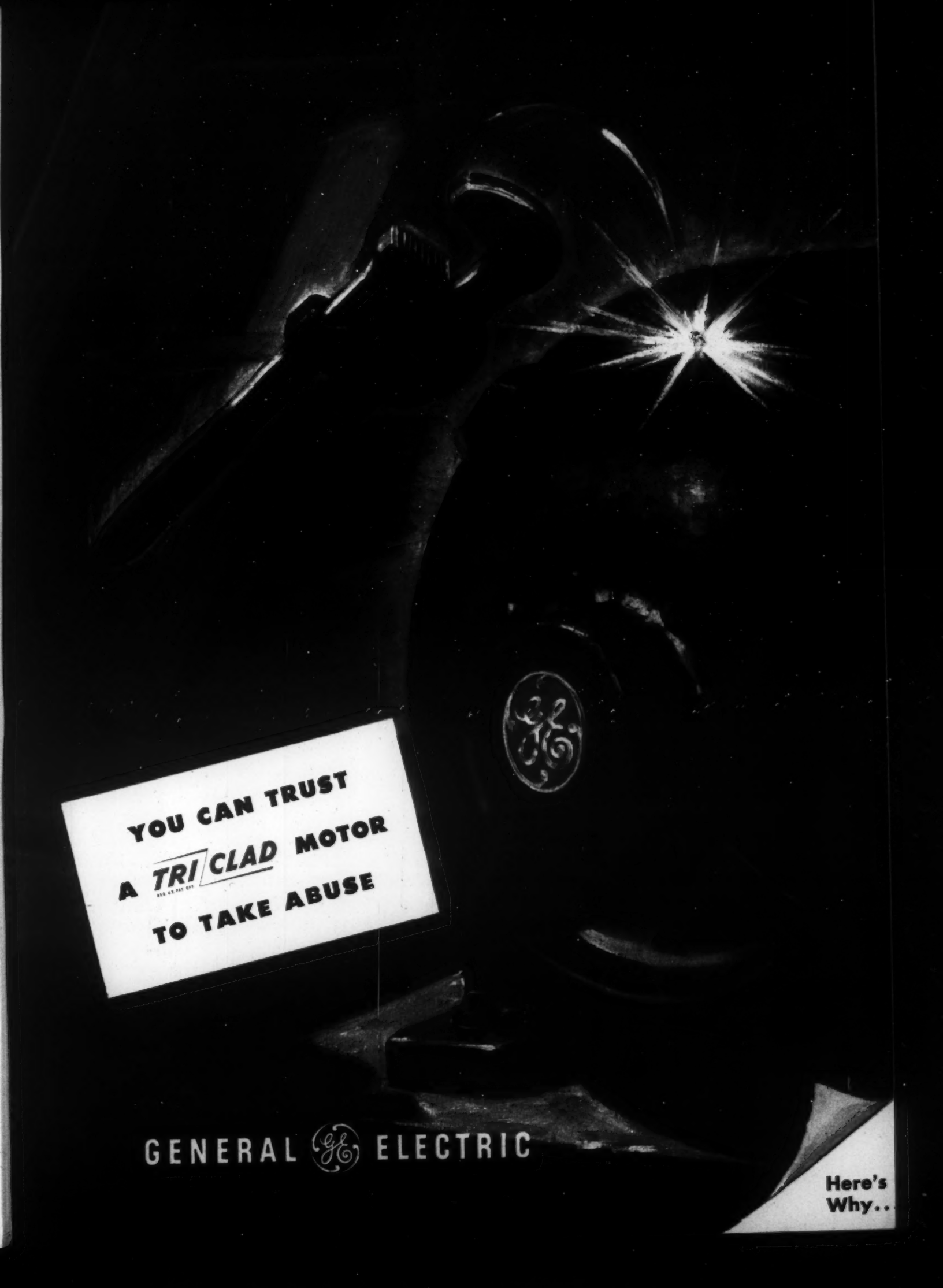
Development of atomic power for aircraft is not a simple undertaking but there are several basic types of power plants that can be adapted to utilize this power for the propulsion of aircraft. These are all thermal power plants, since fission energy is released predominantly in the form of heat. Examples of the types of power plants would be; turbo-props, turbo-jets, ram-jets, and rockets.

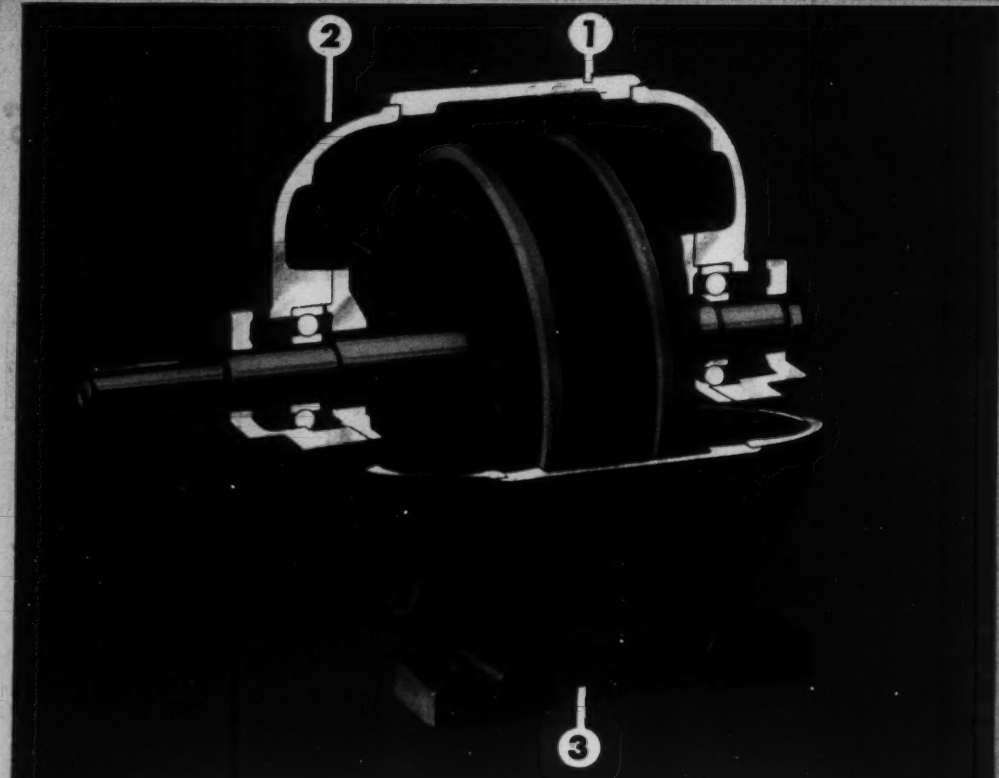
Temperature Problems Severe

Many of the problems which lie in the path of the practical realization of atomic aircraft power plants are connected with the attendant high temperatures. Unlike chemically fueled engines, high thermal efficiency is not the primary reason for wanting high temperatures in a nuclear engine. Specific fuel consumption is of vital importance in a chemically fueled engine. However, for a fuel with a heating value of 40 billion Btu per pound (like uranium), specific fuel consumption is vanishingly small, from a performance standpoint, and thermal efficiency in itself is not a primary objective. High performance is, however, and it calls for high operating temperatures.

The temperature problem is aggravated by the heat transfer problem. In a nuclear engine heat is generated in the solid portions of the reactor and must be transferred to the working fluid through heat transfer surfaces. The internal surfaces of the reactor must be at a temperature higher than the highest temperature of the working fluid. It can only flow if there is a positive temperature differential. This is very different from the internal combustion engine where, as in automobiles, cycle temperatures reach 4000 degrees while internal surface temperatures can be kept down to about

(*Continued on Page* 199)


YOU CAN TRUST
A TRI CLAD MOTOR
TO TAKE ABUSE
GENERAL ELECTRIC
Here's
Why...



Notice the thick cross sections of a Tri-Clad's husky cast-iron stator frame (1) and end shields (2) . . . the integrally cast feet (3). Here you have a *rigid structural unity* that no other general purpose motor we've seen can match. Distortion of bearing alignment is well nigh impossible, even by severe blows, careless installation, or the heavy continuous radial loads some industrial drives impose. Notice, too, how Tri-Clad double-end ventilation provides *uniform* "air conditioning" throughout the motor.

You can trust a TRI/CLAD motor to take abuse

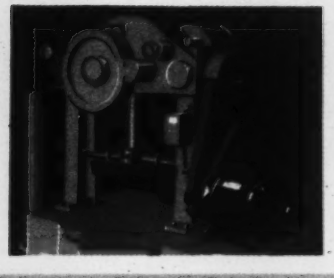
Teeth-rattling blows—accidental jarring—dripping liquids—they're all in a day's work for a Tri-Clad motor—the toughest general-purpose motor that hard-headed plant management can buy.

The cast iron structure which today protects more than a million and a half Tri-Clad motors, is one big reason for its stamina. It absorbs the shock of accidental blows and falling objects encountered in rigorous industrial service. It provides vastly superior resistance to rust and corrosion. Moreover, cast iron won't take on an injurious permanent "set"; thus it assures accurate shaft alignment and a permanent air-gap for the life of the motor. Thick-ribbed cast-iron end shields, too, take more than their share of punishment.

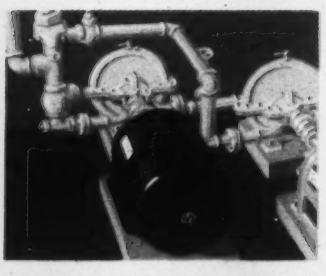
Want to standardize on a line of motors that can really **TAKE ABUSE?** Local stocks of Tri-Clad motors in your area mean **QUICK DELIVERY.** *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

YOU CAN'T BEAT TRI/CLAD EXTRA PROTECTION



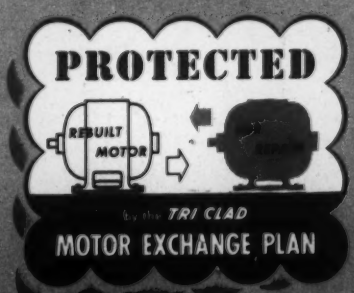
G-E open (drippproof) induction motors for constant-load, constant-speed applications. From 1 to 2000 hp.



G-E totally enclosed motors for outdoor operation, in abrasive dusts, or corrosive fumes. From 1 to 1000 hp.

G-E vertical induction motors for pump drive, in streamline design. From 1 to 500 hp.

G-E capacitor motors for use on fans, blowers, pumps and compressors, with single-phase power. From ¾ to 5 hp.



Look for this **EXTRA** on the motor you buy!

(*Continued from Page* 196)

500 degrees by external cooling.

Broadly, the temperatures necessary for the realization of an atomic engine are not unreasonable from the metallurgical standpoint, but they do engender a number of difficult problems. One of the major problems is "canning" — the protection of the uranium in the reactor against corrosion by the working fluid and, conversely, the prevention of the escape of radioactive fission products from the reactor into the working fluid.

Shielding Boosts Weight

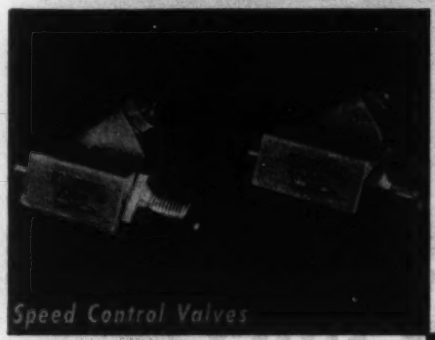
Another crucial problem, as in any airplane, is weight. In an atomic engine it is necessary to use large amounts of mass to stop radiations emitted during the fission process. Comparison with a conventional airplane can help to visualize the magnitude of the weights which may be allotted to shielding. The weight of the propulsion system comprises, substantially, three major items: the power plant proper, the fuel, and the fuel tanks. In the nuclear aircraft these correspond to the "engine" (compressor-turbine assembly in a turbo-jet), the nuclear reactor, and the shielding.

The engine component of the nuclear installation may be expected to weigh approximately the same as a conventional power plant of the same horsepower or thrust rating. The weight of the reactor shielding is, therefore, equivalent to the weight of the fuel and fuel tanks in chemically powered aircraft. Since we are dealing with a relatively thick shield surrounding a relatively small reactor, the apparent paradox holds true that, for a given mass thickness, the greater the density of the shielding material the lighter the shield. If the density of the shielding material is doubled and the thickness of the shield is cut in half, the volume of the shield is decreased by considerably more than a factor of two and the total weight is reduced accordingly.

Choice of shielding materials also presents unusual problems. Existing reactors mostly use large quantities of concrete for shielding, but concrete is hardly a suitable material for aircraft construction. The effect of intense radiations on the properties of the materials must be considered too. It has been found that the electrical resistance, the elasticity, and the heat conductivity of graphite, for example, all change with exposure to intense radiation.

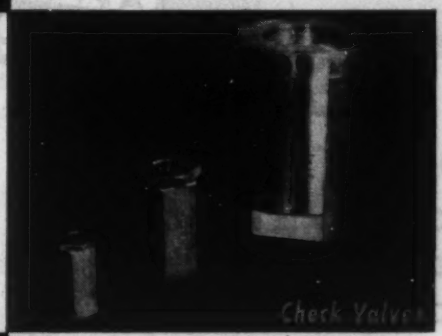
Atomic aircraft will have to be designed to operate at very high speeds to take full advantage of the

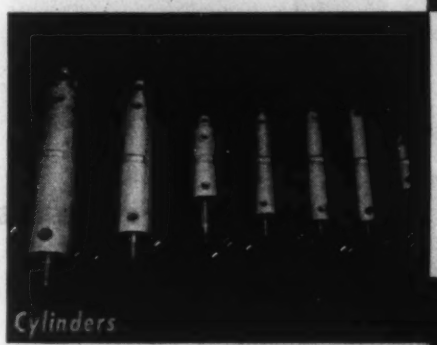
Electrol Hydraulic Devices
For Every Industrial Need


Speed Control Valves

Pictured here are but a few of the many hydraulic devices produced by Electrol for industry . . . transportation . . . and agriculture. We will gladly supply further details as to the application of these units in the machines you use or the products you make. Or — better still—have our engineers work with you in adapting them to any specific design.

Allow flow in one direction and, by use of a metering device, accurately control reverse flow from 0 to valve max. — even after thousands of cycles. Flow controlled by screw-actuated metering pin. Handle air or oil, with pressures up to 1,500 p. s. i. Standard sizes: ⅛, ¼, ⅜, ½ and ¾" N. P. T.


Check Valves


Cylinders

Provide positive sealing from low to high pressures—5,000 p. s. i. max. Used for air, gas, water and oil control with min. pressure drop and positive sealing against return flow. Standard models feature bronze and brass elements. Standard sizes: ⅛ to 2" N. P. T.

"500-1 Series" hydraulic cylinders available in bore diameters ranging from ¾" up to and including 3". Chromium plated piston rods, honed seamless steel tubing cylinders. Conventional "O" ring packings. Clevis mounting and standard pipe ports. Can be used in air or oil. Pressures up to 1,500 p. s. i.

Hand Pumps

Uniform two-way action for maximum operating efficiency. Low in cost, economical in operation. Few moving parts, minimum of maintenance. Operating pressure: 0 to 1,500 p. s. i. Pump delivery: 1.5 cubic inches per cycle. ⅜" N. P. T. ports. Suction and pressure check valves built in.

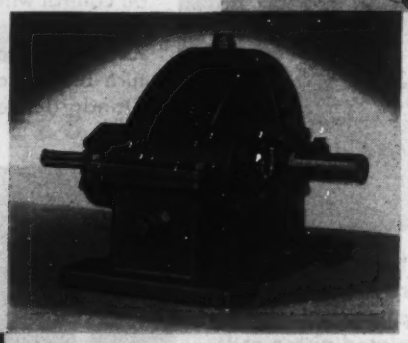
Electrol
KINGSTON, NEW YORK
FOR BETTER HYDRAULIC DEVICES

Better Designed Products Use Electrol Hydraulics

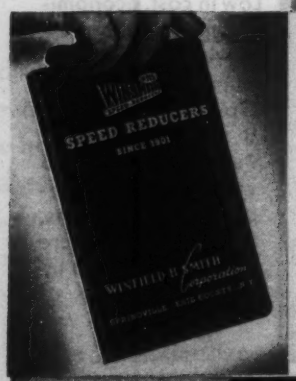
DO IT FOR LESS!

ECONOMY in First Cost
ECONOMY in Operation
ECONOMY in Space
ECONOMY in Long Life

(Above)
"BT" SERIES
Horizontal
Single
Reduction
1/5 H. P. to
12½ H.P.



(at right)
HELICAL GEAR
Horizontal Single Reduction
½ H. P. to 2 H. P.



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Pocket size. Fully illustrates the "Most Complete Line of Speed Reducers from Any One Source." Gives ratios, horsepower, torque, overhung load capacities; valuable engineering section. Ask for Catalog 148.

WINSMITH ENGINEERING SERVICE is at your disposal. Simply outline your problem and our engineers will help you.

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special characteristics of atomic power. Aircraft will have to be large and designed for an extremely high landing weight since practically no fuel will be consumed during flight. Crews will have to be placed as far as possible from the nuclear reactors to protect them from harmful radiations. The problems associated with the development of a nuclear aircraft power plant are by no means easy—nobody should expect to see an atomic powered rocket taking off for the moon this year or next. *From Andrew Kalitinsky's Manly Memorial Medal paper presented at SAE section meetings.*

What Quality Control Does

LACK of adequate quality control programs and preventive inspection is costing American industry more than three billion dollars annually. Failure to anticipate the production of potentially substandard quality products is responsible for this tremendous loss. Increasing the inspection organization will protect the consumer against receiving substandard quality products; however, inspection will not eliminate the loss to industry caused by the scrapping, or reworking of products rejected by the inspection department.

The whole philosophy of quality control may be summed up in the statement *be sure you are right and then go ahead.* Quality control is a preventive tool, and should be used as such. When properly used, it prevents the production of defective units. However, it must be realized that it is necessary that some action must be taken to adjust the process, correct tools, change designs, or otherwise make changes in the process or operation, if the production of defectives is to be prevented or substantially reduced. Experience indicates that in 60 to 80 per cent of the cases such action must come from management.

Every quality control program requires for its successful operation:

1. Clearly defined standards
2. Sufficient inspection coverage
3. Proper inspection methods
4. Correct inspection tools
5. Adequate records.

The results which management has a right to expect, and which it will get, from a properly administered quality control program are:

1. Increased production
2. Lower manufacturing unit costs
3. Improved operator morale
4. Better quality.

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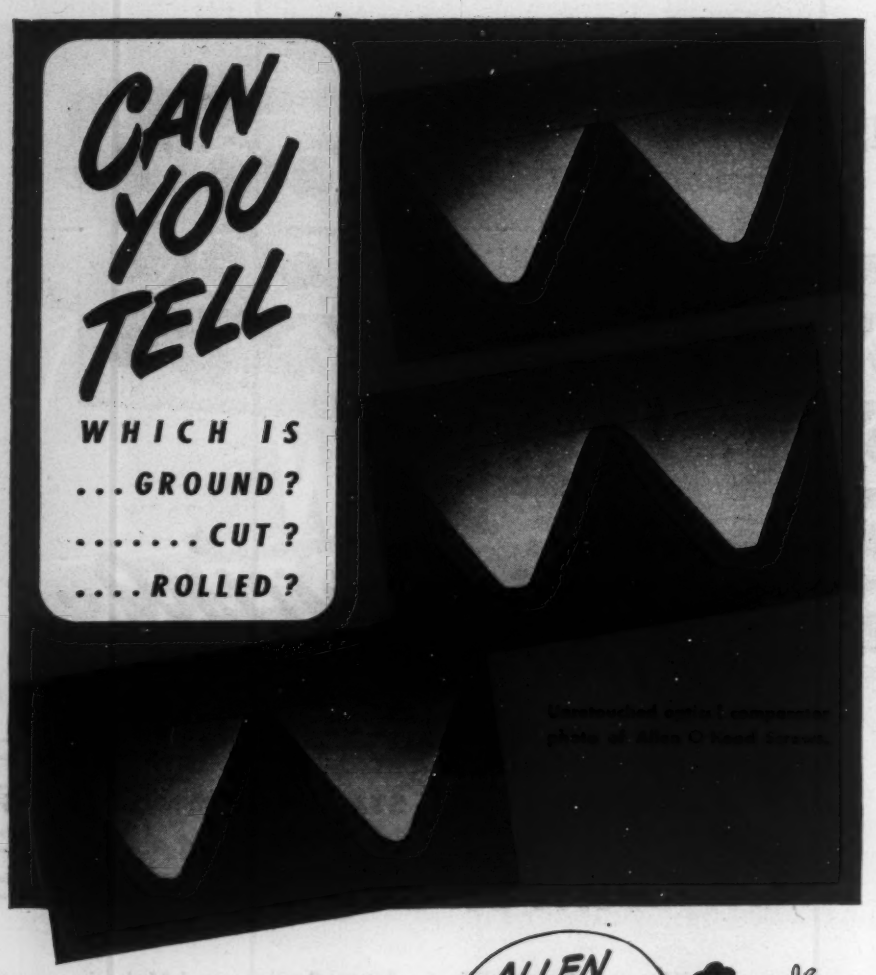

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Quality control has increased production, even on such operations as automatic screw machines, as much as 30 to 35 per cent. When applied to an entire plant, quality control methods have made possible reductions in inspection costs of as much as 50 per cent, while at the same time reducing the cost of scrapping and reworking substandard parts by as much as 75 per cent.

However, it must not be construed that a quality control program will run itself. Quality control requires sincere effort, and high intention on the part of management. It is necessary that it be intelligently directed and skillfully executed in order to obtain the full results of more production, improved operator morale, lower unit costs, and better quality. *From an address by J. Manuele, director of quality control, Westinghouse Electric Corp., presented at the recent conference on production of the American Management Association in New York.*

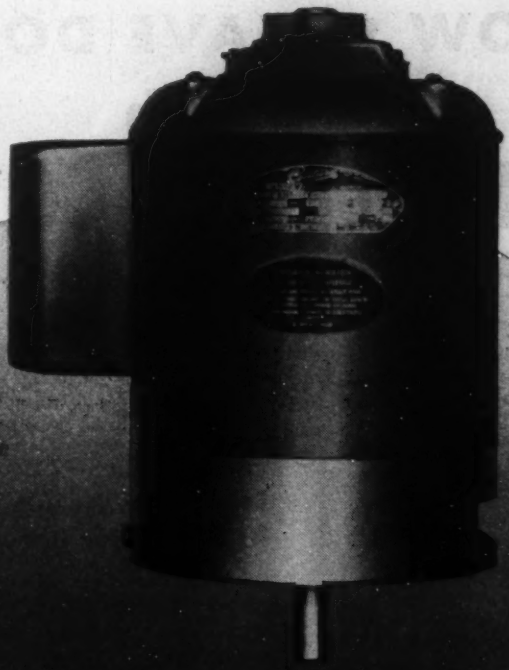
How Straight Thinkers Think

ONE outstanding characteristic of straight thinkers I have known is an active observation coupled with curiosity as to the "how" and "why" of things. This is natural, if we consider that observation is a major stimulus to reasoning.

Original thought can, of course, be painful; habit is Nature's protection against worry. Most of us can remember how worried we once were as to our ability to deal with the new problems and contacts involved in a new job. We can also recollect that, within a few days, the job seemed to become easier; we weren't afraid of it; we could relax and handle the routine. In other words, we had acquired a mental habit. Very few of us could stand it, I think, if we had to go to an entirely new and different job every three days in order to make a living. So actually, habit of thought, the ability to fall back on precedent in dealing with our problems, is one of the merciful things in our life.

But, we should recognize habit of thought for what it is—a palliative or sort of rest. We should be careful not to rely on it more than we have to. Just as hanging from a horizontal bar one minute each day will keep a man from becoming stoop-shouldered, so one daily episode of original thinking will do much to keep us out of a rut.

Another characteristic of successful straight thinkers is confidence in their ability to reason correctly even though contrary to current opinion. This, I suppose, comes partly from ex-



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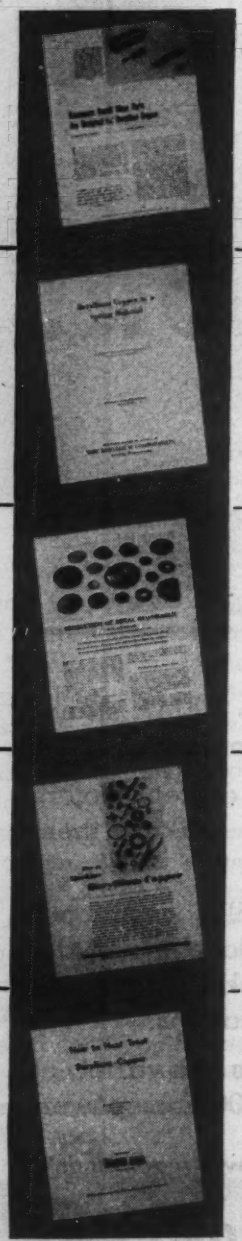

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perience and partly from reliance upon the universality of Nature's laws. Perhaps the greatest factor in the Wright Brothers success was that after watching gulls, with a ratio of wing area to weight which they (the Wright Brothers) could reproduce, glide slowly through the air close beside them, they had an unshakeable conviction that, given an engine as good as that of the 1903 automobile, men simply had to be able to fly. So, being absolutely convinced that flight was possible, it was easy for them to pursue their long and difficult road of development despite public unbelief.

The old idea of invention was to look at something nearly everybody else had seen, and get a new "hunch" on it. Actually, the best formula for invention is to develop a new method of seeing something no one else has yet observed; find out how it acts, then employ common sense to put it to use.

Inventions not "Flashes of Genius"

Most of the so-called inventions with which I am familiar, that were major steps forward, were not flashes of genius at all, but instead were inevitable conclusions from new observation plus straight reasoning. Even on smaller problems, when you are at an absolute loss and can't imagine what to do next, go out and experiment with anything that even simulates the action desired. The chief danger of mathematical analysis without experiment is the great chance of ignoring or wrongly appraising major determining factors.

Summarized, my suggestions for stimulating and using original thinking are:

(a) Cultivate the habit of analyzing problems on the basis of what you know; what you need to know; and how to go about learning what you need to know

(b) In a new development, follow this sequence: Analyze, observe or experiment, re-analyze, again check by experiment and so on, until both theory and observation correlate

(c) As a result of the foregoing, have full confidence in your conclusions, regardless of current opinion to the contrary; but, be practical!

(d) In new development, check the basic factors first

(e) Study how your mind works best and easiest; and learn how to employ it that way.

From a paper by F. C. Mock, Bendix Aviation Corp., presented at the recent SAE Detroit Section student activity meeting.

Left—5 of the 55 pieces of luggage in the smart Samsonite line. All are now equipped with lustrous, solid brass fittings to make Samsonite Luggage look better longer.

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Revere Brass Strip selected for its unusually fine, uniform grain after hardware is formed.

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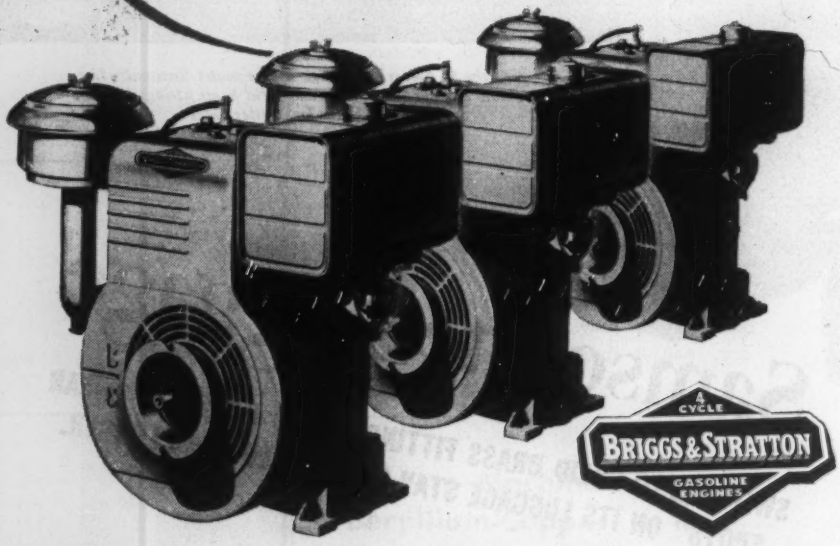

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Refrigeration Equipment Manufacturers Association. Sixth all-industry refrigeration and air conditioning exposition to be held in Atlantic City Auditorium, Atlantic City, N. J. R. Kennedy Hanson, 1107 Clark Bldg., Pittsburgh, Pa., is director.

Nov. 27-30—

National Automatic Merchandising Association. Convention to be held at the Atlantic City Convention Hall, Atlantic City, N. J. Additional information may be obtained from Thomas Hungerford, Director of Public Relations, 120 S. LaSalle St., Chicago, Ill.

Nov. 27-Dec. 2—

American Society of Mechanical Engineers. Annual meeting to be held at the Hotel Statler, New York, N. Y. C. E. Davies, 29 West 39th St., New York, N. Y., is secretary.

Nov. 28-Dec. 3—

Chemical Industries 22nd Exposition to be held at Grand Central Palace, New York. Additional information may be obtained from the International Exposition Co., Grand Central Palace, New York 17, N. Y. Charles F. Roth is manager.

Nov. 30-Dec. 2—

Society For Experimental Stress Analysis. Annual meeting to be held at the Hotel New Yorker, New York. W. M. Murray, Central Square Station, Cambridge 39, Mass., is secretary-treasurer.

Dec. 4-7—

American Society of Refrigerating Engineers. 45th annual meeting to be held at the Edgewater Beach Hotel, Chicago, Ill. David L. Fiske, 40 West 40th St., New York 18, N. Y., is secretary.

Dec. 19-21—

American Society of Agricultural Engineers. Winter meeting to be held at the Stevens Hotel, Chicago, Ill. Raymond Olney, P. O. Box 229, St. Joseph, Mich., is secretary.

Jan. 9-13—

Society of Automotive Engineers. Annual meeting and engineering display to be held at the Book-Cadillac Hotel, Detroit, Mich. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

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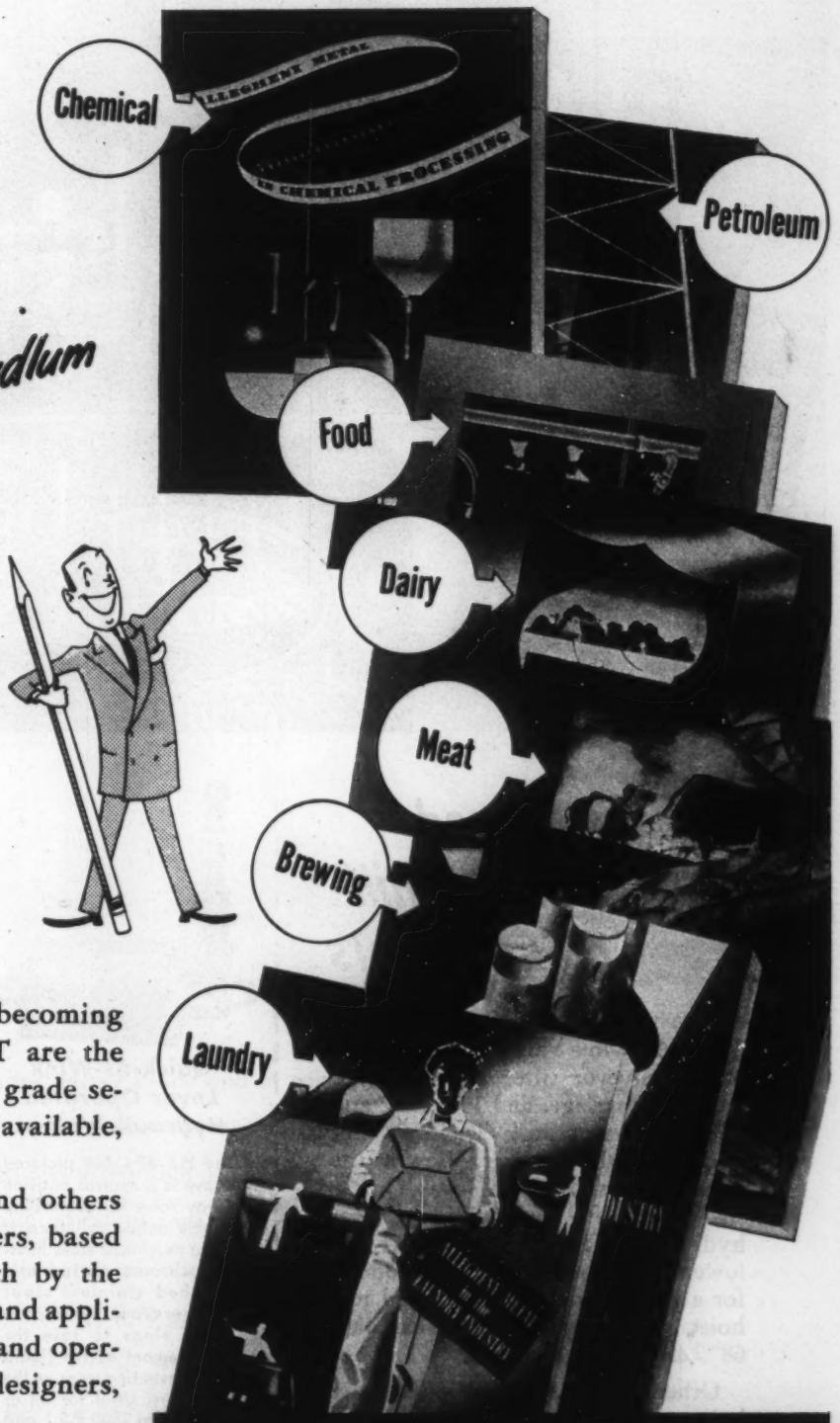

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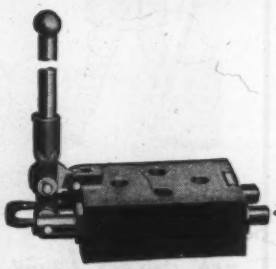

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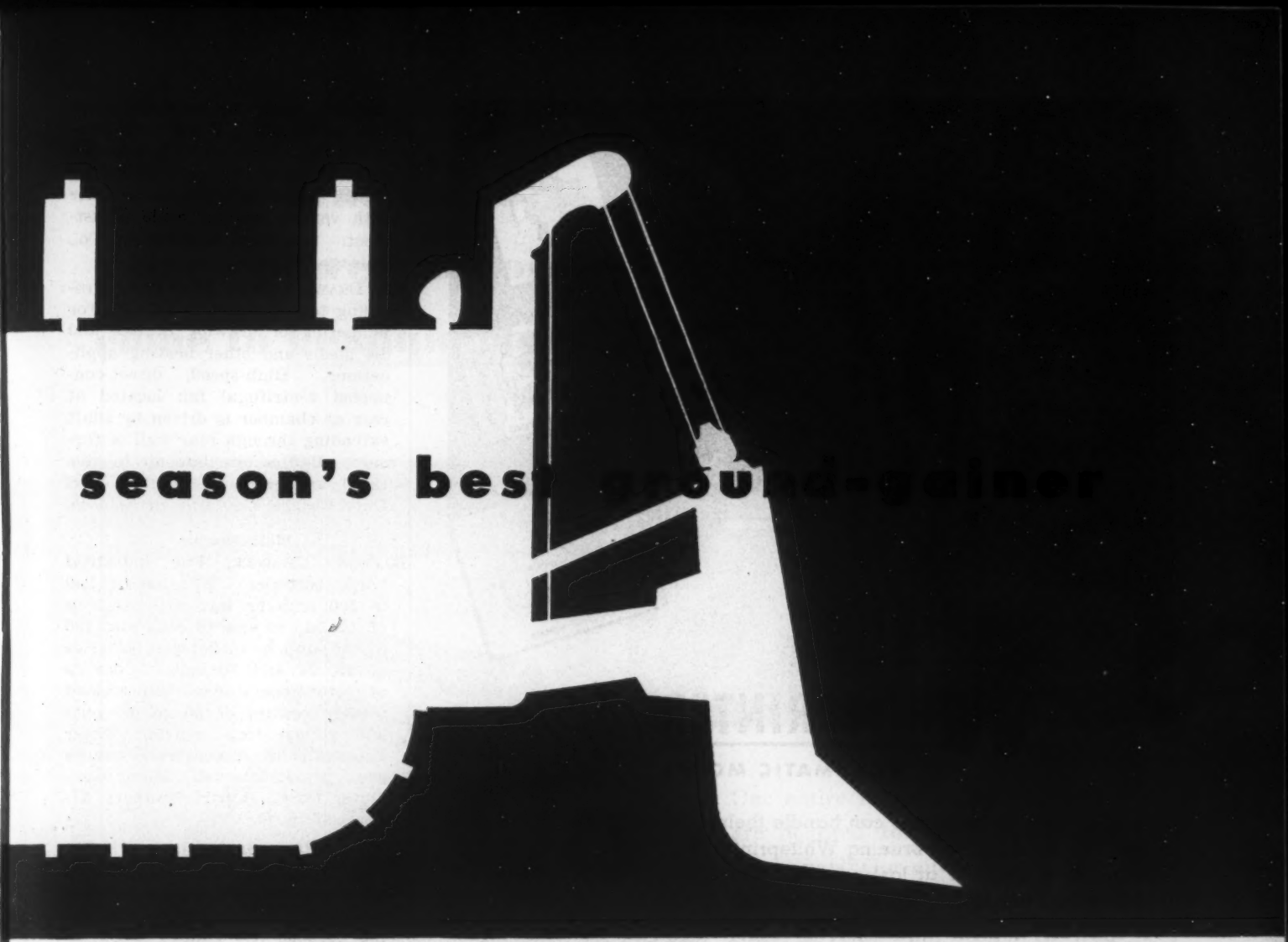

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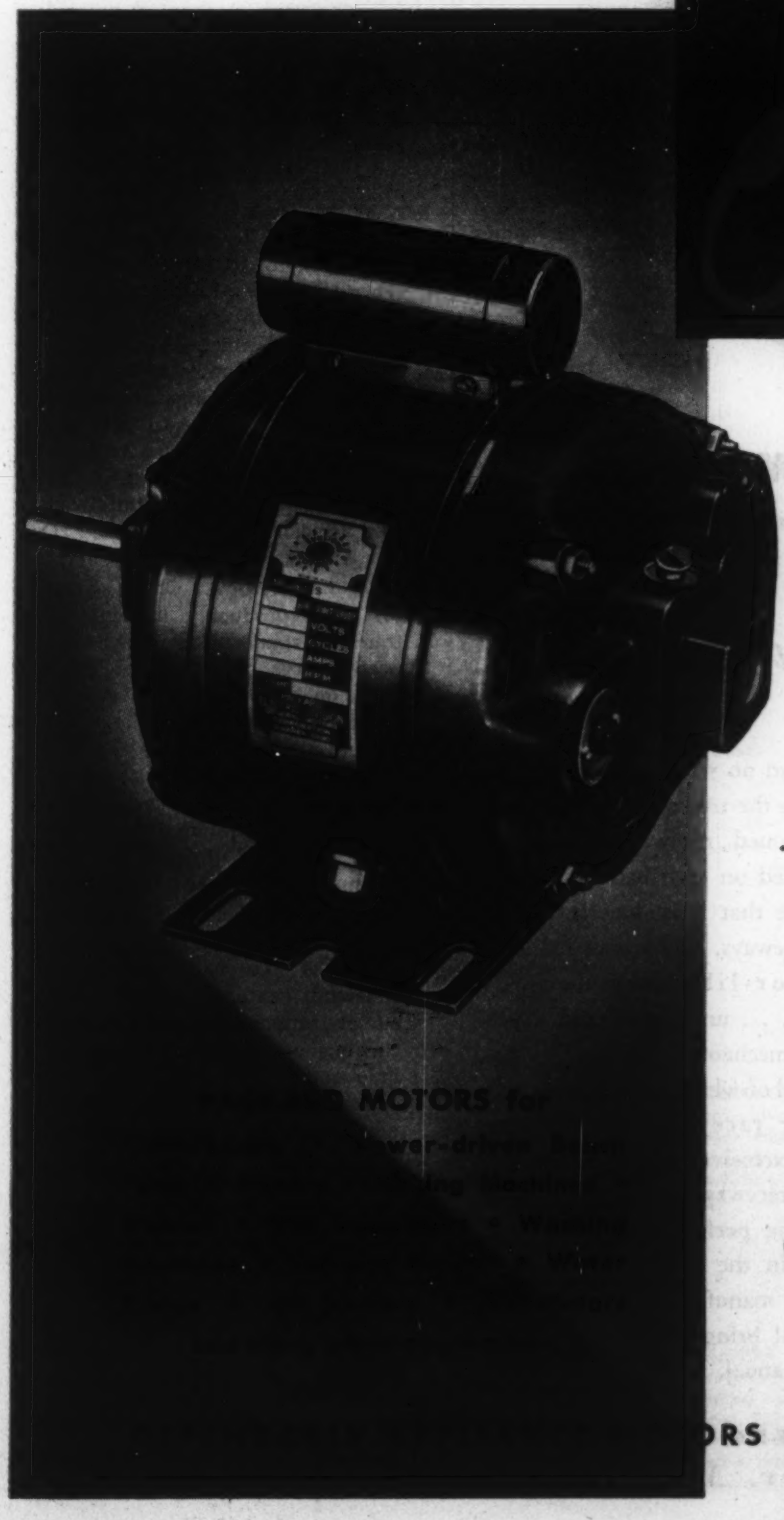

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Hoover Ball and Bearing Co.
Ann Arbor, Michigan

sufficient side pressure to allow lifting without pallet. Mounted on revolving apron attachment permitting turning of loads 190 degrees in one direction or 95 degrees in either direction. Special purpose arms permit handling bales, boxes, crates, cartons and drums. Capacity, 1930 to 3280 lb, depending on length and type of arms used. Hyster Co., Portland, Oreg.

HAND-OPERATED LIFT. Capacity, 1000 lb. Has operating platform 24 by 30 in., lowered height of 5½ in., lifting height of 58 in., and overall height of 76 in. Planetary gear drive hoisting mechanism raises or lowers lifting carriage 1½ in. with each revolution of crank. Caster mounted for moving. Lewis-Shepard Products Inc., Watertown, Mass.

Manufacturing

DIE FILER. Uses ⅛ or ¼-in. shank files. Stroke length variable from 3/16 to ¾-in. by setting double eccentric. Spring-loaded reciprocating mechanism automatically compensates for wear. Neoprene bellows keeps filings out of reciprocating shaft bearings. Graduated plate permits accurate setting of 8½ by 8½-in. table. Adjustable roller support backs up files. Powered by 1/6 or ¼-hp motor through belt drive. Benchmaster Mfg. Co., Los Angeles, Calif.

GRINDING MACHINE. Crush grinder for mass producing intricate contours in small metal parts. Wheel head moves vertically to contact work on table; indexing table then rises to preset stroke. Work ground in single pass of wheel head. Work table stroke variable from 3 to 16 in. at feed rates to 15 fpm. Will handle 160 parts per cycle with 25 cycles per hour. Thompson Grinder Co., Springfield, O.

AXLE CENTERING MACHINE. For centering of new railroad axles and renewing centers on either mounted or unmounted axles prior to turning operations. Consists of 2 axle chucking units and 2 sliding spindle heads mounted on bed. Spindles driven by 3-hp motors through worm gearing. Chuck jaws handle journals 4¼ to 6½ in. diameters. Journals can be trued with approximately ½-in. depth of cut. Renewed centers machined to within 0.005-in. concentricity with journals. Niles Tool Works Co., Division of Lima-Hamilton Corp., Hamilton, O.

BAND SAW. Electrically driven blade. Hydraulic controls include raising and lowering of cutting heads. Capacity, 9 by 18 in.; clearance un-

FELT, LIKE RADIO, HAS NO HORIZONS

Just as radio signals can be picked up and put to use almost anywhere, so felt has infinite usefulness. It is a material of a million uses, in home and factory, products and processes. Sound absorption—thermal insulation—wicking—sealing—packing—gasketing—vibration and shock dampening—lubrication—polishing; these are but a few of the hundreds of applications which make felt one of the engineers' most versatile and useful materials.

When you think of felt, think far beyond hats and slippers. Think of engineered felt—American Felt! As made by American Felt Company, felt is a strictly-controlled engineering material, accurately standardized in many types for an infinite number of industrial as well as textile applications. In practically every factory in this country felt contributes to the economy and reliability of machinery. Consumer products in the greatest variety, from clothing to automobiles, are better because felt is used in them. Some examples of felt's uses are shown here. It will pay you to study them and ask yourself if you are making full use of this material that is so versatile because it can be endowed with so many different characteristics. Please write on your letterhead for

THE STORY OF FELT.

American Felt Company

TRADE MARK

GENERAL OFFICES: 22 Glenville Road, Glenville, Conn.
PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

NOTE TO DESIGNERS

No matter what the project may be on your boards, the chances are that felt can help you make it better or more economically. Remember, felt is an engineering material which can be specified exactly. Send for illustrative samples and technical data sheets published and distributed by American Felt Company.

SEALS. Felt seals—plain, laminated, or impregnated—retain grease and oil, are self-lubricating, and exclude dust, fumes, water, and mud. Used to seal bearings, housings, etc.

WICKS. Felt wicks—designed and engineered for controlled operation, feed oil to bearings and remote friction points, or deliver other fluids where they are wanted.

VIBRATION. Felt vibration mountings, placed under machines or other equipment, are effective in dampening shock or absorbing up to 80% of the vibration.

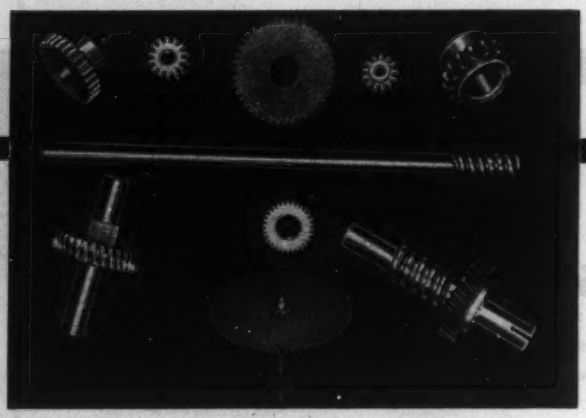
FLAME PROOFING. Felt for aircraft, theatrical and other mechanical or decorative applications is flame proofed so that it will not support combustion or propagate flame.

TROPICALIZATION. Felt can be tropicalized to resist fungi, mildew, vermin, moths, moisture. Such felt is a vital part of many products going into tropic countries, giving lasting protection against destructive rot and insect infestation.

COATING. Coatings such as natural rubber, synthetic elastomers, or vinyl resins can be applied to felt, producing an impervious surface or adhesive backing for quick easy application. Either heat or pressure sensitive backings may be employed.

PACKING. Vistex is a rubber-impregnated felt-base packing and sealing material in several different types. TCR Vistex is highly resistant, for example, to tricresyl phosphate, and is recommended for hydraulic systems using that special fluid.

SOUND ABSORPTION. Special "K" felt, widely used in airplanes, theaters, and elsewhere, absorbs sounds, reduces noise transmission or improves acoustics. This felt also provides thermal insulation and is safe because it is flame resistant.



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Rynel Corporation
STERLING, ILLINOIS

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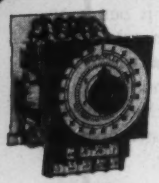
FOR CONTROLLING INDUSTRIAL PROCESSES



MICROFLEX TIMER

MICROMETER DIAL

Provides exceptional timing accuracy where a circuit is to close or open with a time delay. Timing adjustable over wide range.

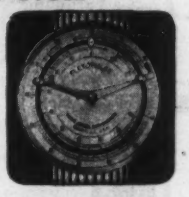
MULTIPLE CIRCUIT —ADJUSTABLE

Use where several circuits are to close in a predetermined sequence. Time of closing and opening each circuit is adjustable.

MULTIFLEX TIMER

REPEAT CYCLE

Use where ON-OFF operation is continuously repeated. The ON time and OFF time are each adjustable on the dial.



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COUNTER

Use for limiting a process to an exact number of operations. The counter contact opens after 1 to 400 electrical impulses as selected on dial. Automatic spring reset.

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Write for catalog Bulletin 291 or send details of your control problems to Eagle for recommendations. Consult Eagle representatives located in the principal cities.

EAGLE Signal Corporation
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der saw blade, 20 in. Vise swivels 45 degrees in either direction. W. F. Wells and Sons, Three Rivers, Mich.

ARC WELDER. Stationary and portable heavy-duty models for pipeline work, construction jobs, etc. Ratings, 300 and 400 amp. Includes d-c, 40-volt, variable-voltage, self-excited generator. Generator driven by V-belts from 6-cylinder industrial engine. Dimensions: length, 76 in.; width, 28 in.; height, 49 in. Air Reduction Sales Co., New York, N. Y.

DRILLING MACHINE. Vertical continuous model uses change gears to govern cycling time and spindle speeds. For reaming 2 sizes of intake and exhaust valve guides. Includes eight 20-station automatic indexing type fixtures mounted on 8-spindle vertical driller. Parts loaded by hand, ejected automatically. Production rate, 2520 pieces per hour. Davis & Thompson Co., Milwaukee, Wis.

THREADING AND TRIMMING MACHINE. Will also bead, knurl or curl such items as cans, flashlights, bottle caps, etc. Handles products made of material to $\frac{5}{32}$-in. thick. Powered by 2-hp, 900-rpm motor through V-belt drive. V & O Press Co., Div. Rockwell Mfg. Co., Hudson, N. Y.

DRAWING PRESS. High-speed, triple-action model for stamping roofs of automobile bodies. Unit weighs over 600 tons with dies. Handles dies up to 200 in. long, draws to 24 in. deep. Drawing speed, 70 fpm; operating speed, 6 strokes per minute. Operating speed represents 75 per cent production increase over previous models of same capacity. Plunger slide is in bed and travels upward when making draw, permitting stampings to come out of die right side up. Lima-Hamilton Corp., Detroit, Mich.

SMALL PUNCH PRESS. Capacity, 1 ton. For light punching, shearing, staking, riveting, forming, coining, etc. Has max stroke of $\frac{3}{4}$-in. with $\frac{3}{4}$-in. hole in ram. Approximately 290 strokes per minute with 1725 rpm, $\frac{1}{4}$-hp motor. Employs single-trip safety mechanism, or ram can be made to repeat. Dimensions: height, 17½ in.; die space to bolster plate with ram up, 3½ in.; throat depth, 2⅛ in. Weight, less motor, 65 lb. Benchmaster Mfg. Co., Los Angeles, Calif.

PORTABLE SPOT WELDER. Welds metals to combined thickness of ⅛-in. Weight, 14½ lb. Dimensions: length, 17¼ in.; width, 3 in.; height, 8½ in.; depth of throat,

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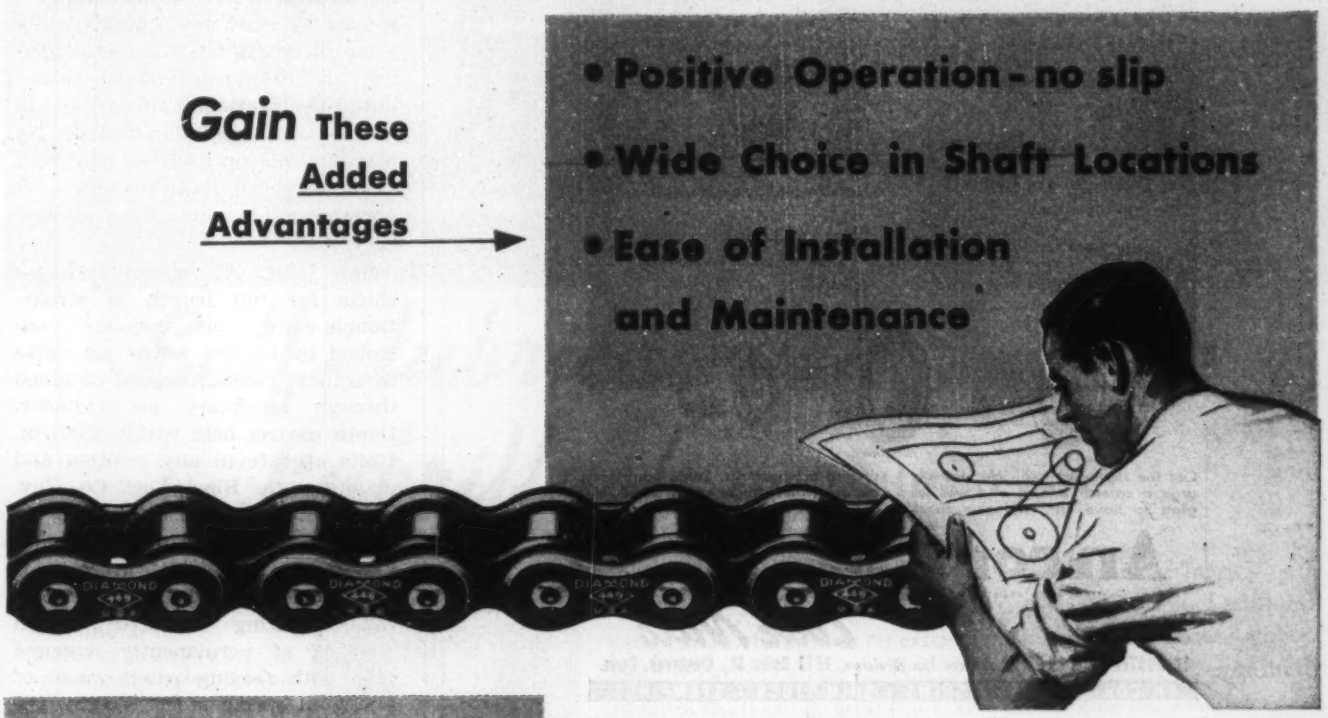

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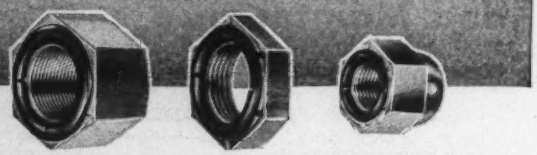

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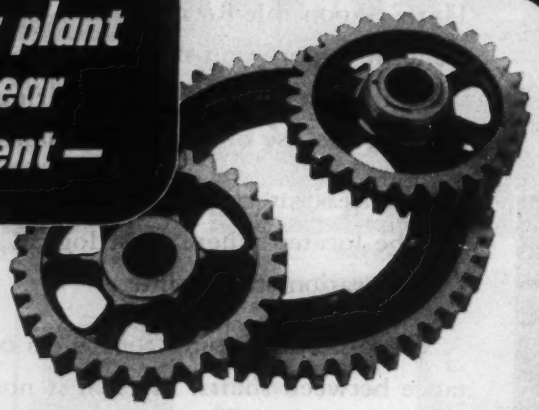

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7¼ in. Operates from 115-volt, 60-cycle, 25-amp current outlet. Fitted with 3 current taps. Welderon Co., Providence, R. I.

WELDER. Rated capacity, 250 amp. For job shop and industrial welding. Uses electrodes from $\frac{5}{64}$ to ¼-in. diameter. Arc booster adjusts welder to start arc automatically when electrode touches metal, giving arc extra current to secure initial penetration. Unit enclosed in pressed steel case 25 in. high. No moving coils or leads in windings. Unit equipped with wheels for portability. Lincoln Electric Co., Cleveland, O.

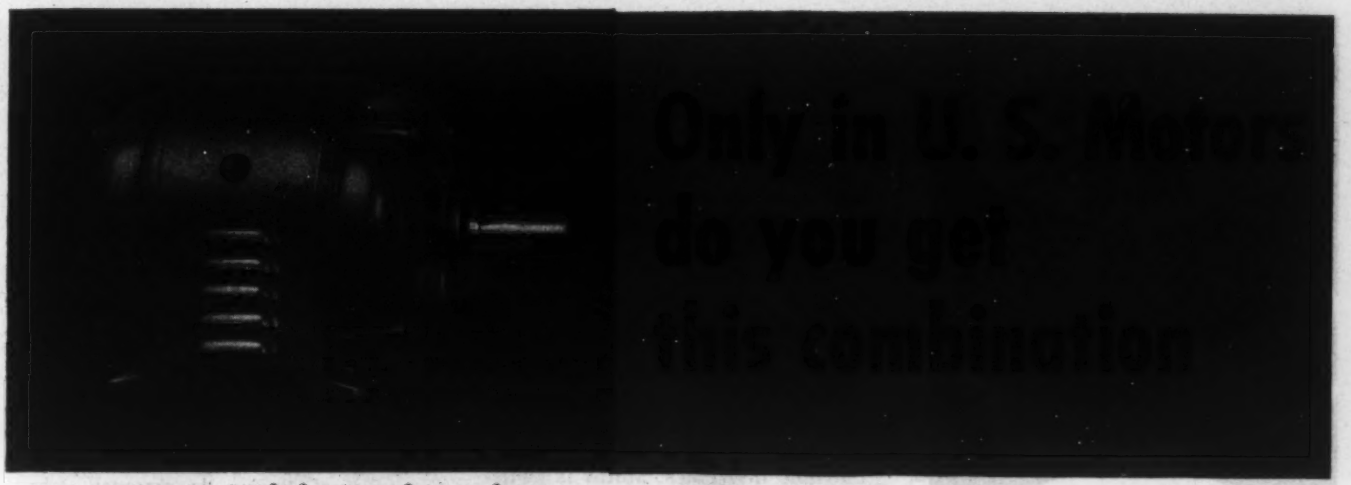
TAPPING UNIT. Air operated. Rotor shifts for full length of stroke. Double-acting air cylinder controlled by built-in 4-way air valve to actuate rotor. Reversal obtained through secondary air cylinder. Depth control held within 0.001-in. Units operate in any position and at any angle. Black Drill Co., Div. of Black Industries, Cleveland, O.

ROTARY PNEUMATIC TOOL. For driving Screwsticks. Pneumatic rotor is of one piece construction, ball and roller bearing mounted. Clutch gear is of permanently engaged type with feeding pawls made of tempered spring steel. Weight, 1¾ lb; overall length, 6½ in. Independent Pneumatic Tool Co., Aurora, Ill.

ROTARY GEAR FINISHER. High-production, crossed-axis model for finishing heavy-duty gears. Two models handle spur or helical gears and involute splines from zero to 18 or zero to 24 in. diameter and to 15-in. face width. After setup, machine operation is automatic with exception of loading. Gears shaved by any of 3 methods: underpass, transverse, or traverpass. Can curve-shave or crown either wide-face or narrow gears. Automatic rapid-approach feed and automatic in and return feeds included. Michigan Tool Co., Detroit, Mich.

CRANKSHAFT FINISHER. For 5 drilling and 2 milling operations on refrigerator crankshafts. Progressively drills 2 deep oil holes, one in 3 stations and the other in six stations. Handles 145 pieces per hour with unskilled operator. All operations except loading and unloading performed automatically. The Cross Co., Detroit, Mich.

PORTABLE SPOT WELDER. Weight, 23¼ lb. For intermittent-duty spot welding of stainless and mild steel to ⅛-in. combined thickness. Operates on 220-volt, 50/60-cycle, single-phase power. Alternate tongs available with tips set at 90 or 45

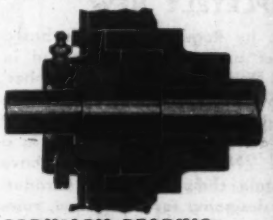


Self-lubrication FOR NORMAL LIFE

plus *Lubriflush* FOR LONGEST LIFE

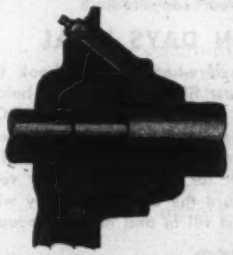
AFTER LONG SERVICE ANY BEARING MUST BE PURGED

Worn-out grease in a bearing must eventually be replaced with new lubricant to insure *longest* motor life.



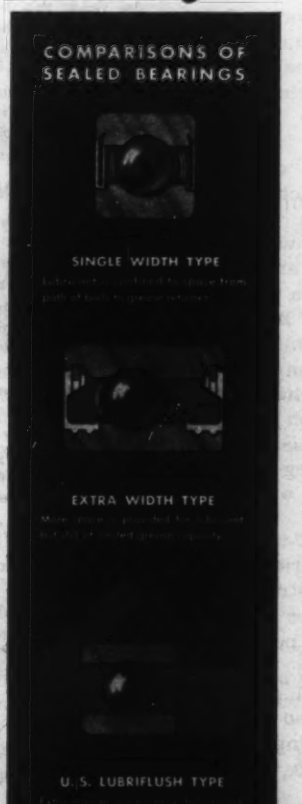
ORDINARY BEARING

No way is provided for thoroughly flushing grease from dead end behind bearing.



U.S. LUBRIFLUSH BEARING

Provides thorough flushing without disturbing bearing. New lubricant is forced behind and through bearing, purging old, worn-out grease.



To get the greatest endurance from a motor, positive lubrication is essential. U. S. Motors offer the unsurpassed combination of self-lubrication and Lubriflush at no extra cost. Years of extra service without re-lubrication can be expected. Then if you desire to eventually re-lubricate, it can be quickly and easily accomplished. You don't have to disassemble the motor to re-lubricate. You simply remove drain and apply a grease gun while the motor operates. There's no guesswork.

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You pay no more for U. S. Motors with Lubriflush than for ordinary motors. So why not gain the advantages of self-lubrication plus Lubriflush? Remember—bearing failure is costly. It may delay your production. *Avoid bearing replacement by Lubriflushing.* Your motor will deliver years of extra life.

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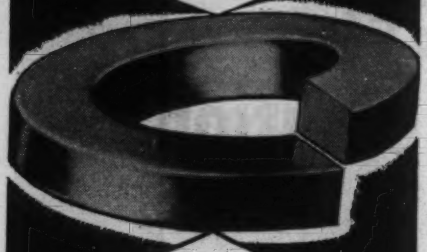

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The life of the assembly is usually determined by the length of the Power Zone of the fastening device. Diamond G Spring Lock Washers have been designed, developed and torture-tested to provide the maximum Constant Power Zone . . . longer positive holding power.

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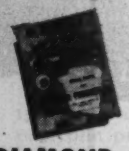

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DIAMOND G PRODUCTS

Manufactured by

GEORGE K. GARRETT CO., INC.

Philadelphia, Pa.

GARRETT

MANUFACTURERS OF SMALL PARTS

degree angles as well as telescopic style tongs giving larger throat depth. National Cylinder Gas Co., Chicago, Ill.

WELDER. Low cost model rated 200 amp at 30 volt on 50 per cent duty cycle. Current range, 40 to 250 amp at operating speed of 3450 rpm. Unit dimensions; 26¼ in. long, 18 in. wide, 25 in. high. Weight, 340 lb. Has 5 ranges of welding current and 100 steps of voltage-ampere adjustment in each range for total of 500 combinations of open-circuit voltage and welding current. Generator is modified multirange type with 4 laminated main poles and 4 removable interpoles. Motor is squirrel cage induction type. Hobart Brothers Co., Troy, O.

PUNCH PRESS. Can be inclined up to 36 degrees. Dimensions: bolster plate, 32 by 34 in.; ram face, 14 by 18 in.; die space, 14 in. standard and 18 in. max. Handles work to 16¾ in. deep at 45 pieces per minute in either vertical or tilted position. Tilted position allows work to drop away without use of ejector. Tripping device protects operator in event of spring breakage. Johnson Machine & Press Corp., Elkhart, Ind.

STUD WELDER. Single gun, capacitor-operated, self-timed machine handling tip studs to ½-in. diameter. Necessary hammer blow follows main current discharge and causes parts to weld. Arc time of 1 millisecond allows use of high currents, permits welding on thin metal, and reduces distortion of work. Welding pressure mechanical or pneumatic. Operates on 110, 220 or 440-volt, single-phase current. Graham Manufacturing Corp., Ferndale, Mich.

Woodworking

PORTABLE SANDER. Electric-powered hand model gives straight-line sanding motion that does not cross grain. Abrasive holder permits attaching several sheets at same loading. Designed for 1 or 2-hand operation, unit can also be used for rubbing and polishing. Detroit Surfacing Machine Co., Detroit, Mich.

ROUTER. For small shop or hobby work; especially for relief work, shaping edges of all types and routing contoured cut-out work. Detachable motor has shaft speed of 18,000 rpm. Micrometer depth adjustment can be set from zero to 1 in. Chuck capacity, ¼-in. adaptable to 1/16, ⅛ and 3/16-in. Shaft size, 7/16-in. at chuck end. Weight, 6¼ lb; max height, 8 in.; base diameter, 5½ in. Porter-Cable Machine Co., Syracuse, N. Y.

Just Off the Press

PRODUCTION PROCESSES

. . . Their Influence on Design

by Roger W. Bolz

Associate Editor, Machine Design

568 pages * 6½ x 10 inches * 652 illustrations

Design engineers! Here's a new working tool that you will want to keep right at your fingertips. This new book is your answer to the problem of how to design specifically for production. It is packed from cover to cover with facts and figures on 36 different production processes. It gives the character, scope, capabilities and limitations of each process. It thoroughly covers all the different design factors involved in Metal Removal, Forming, Working, Forging, and Deposition. And it gives down-to-earth data on such factors as how to select materials . . . the surface finishes produced by various processes . . . and the practical tolerances which can be held while using various processes.

Written by an acknowledged authority in the field, this book puts design on a rational basis. It will help you save money by avoiding costly design errors before production begins. It will show you how the parts you design are actually produced, it will acquaint you with the different production processes and show you the pitfalls to avoid when designing for these processes.

COMPLETELY NEW

This new book by Roger W. Bolz is based upon the series of articles which appeared in Machine Design Magazine up to September, 1948. Every chapter has been entirely rewritten, expanded and revised to include all the pertinent factors not possible to cover in a magazine article. New chapters which have been added contain completely new introductory material on designing for production, rules to be followed generally, and examples of savings possible by designing for a specific process. This book should be in the technical library of every design engineer. Use the convenient coupon to order your copy today!

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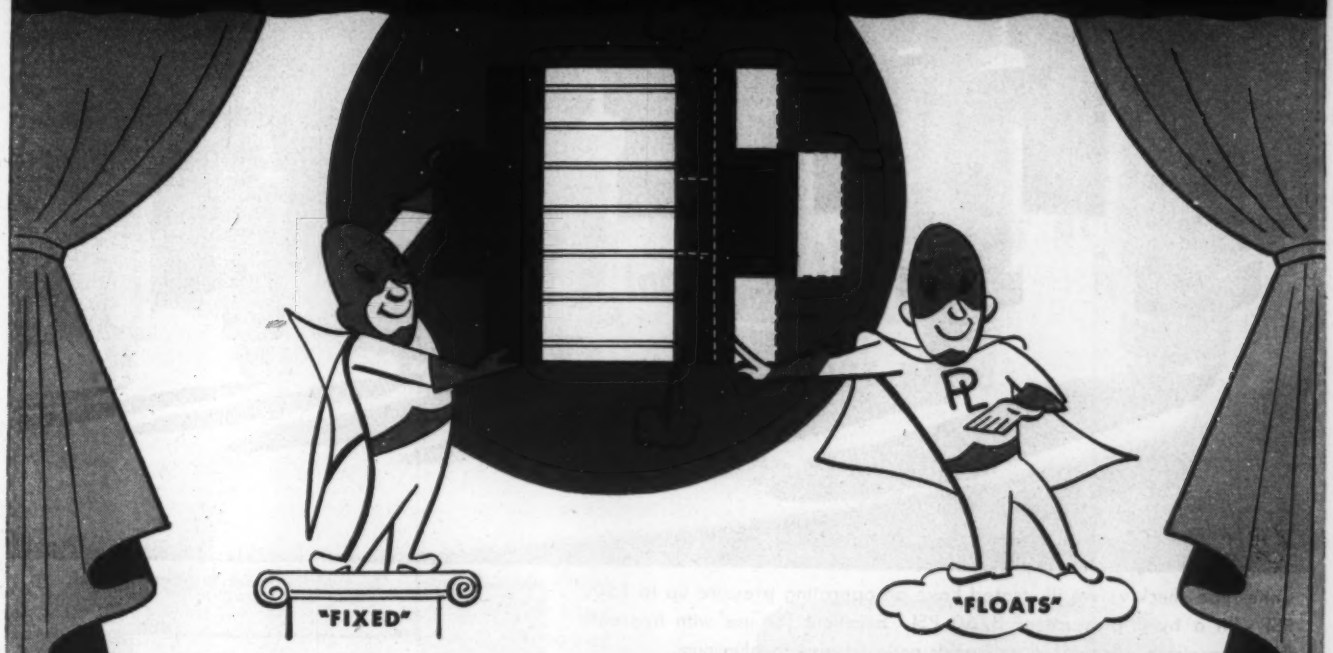
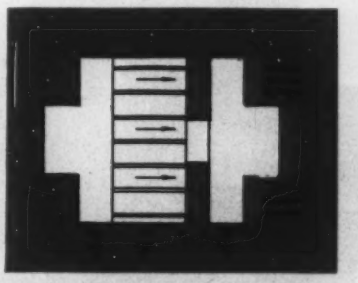


...The Greatest Little Act in Hydraulics

Yes, sir, "Fixed" and "Floats" are the famous "PL"* twins, Pesco's exclusive hydraulic pump act that provides volumetric efficiencies up to 97% . . . torque efficiencies up to 90% . . . and assures these efficiencies over a longer service life.

"Fixed" is an old-timer at this kind of an act. But it's "Floats" that really wows 'em. He's the one that *automatically* holds end clearance to a thin film of oil, making possible maximum torque and operating efficiencies under all operating conditions. Together, "Fixed" and "Floats" make possible Pesco's patented "Pressure Loading" principle of construction for gear-type hydraulic pumps. Here's their act:

*"PRESSURE LOADING"... How it works



The schematic illustration at right shows the three principal parts of a gear-type hydraulic pump. They are the bearings ("A" played by "Fixed" and "C" played by "Floats") and the gear ("B"). Bearing "A" is fixed. Bearing "C" floats. By means of the "Pressure Loading" principle, pressure from the discharge of the pump is transmitted through a "Pressure Loading" passage and is exerted against the rear of the "floating" bearing. This force is counter-balanced by pressure developed within the gear cavity so that the thrust of the bearing against the gears is just enough to accomplish its purpose.

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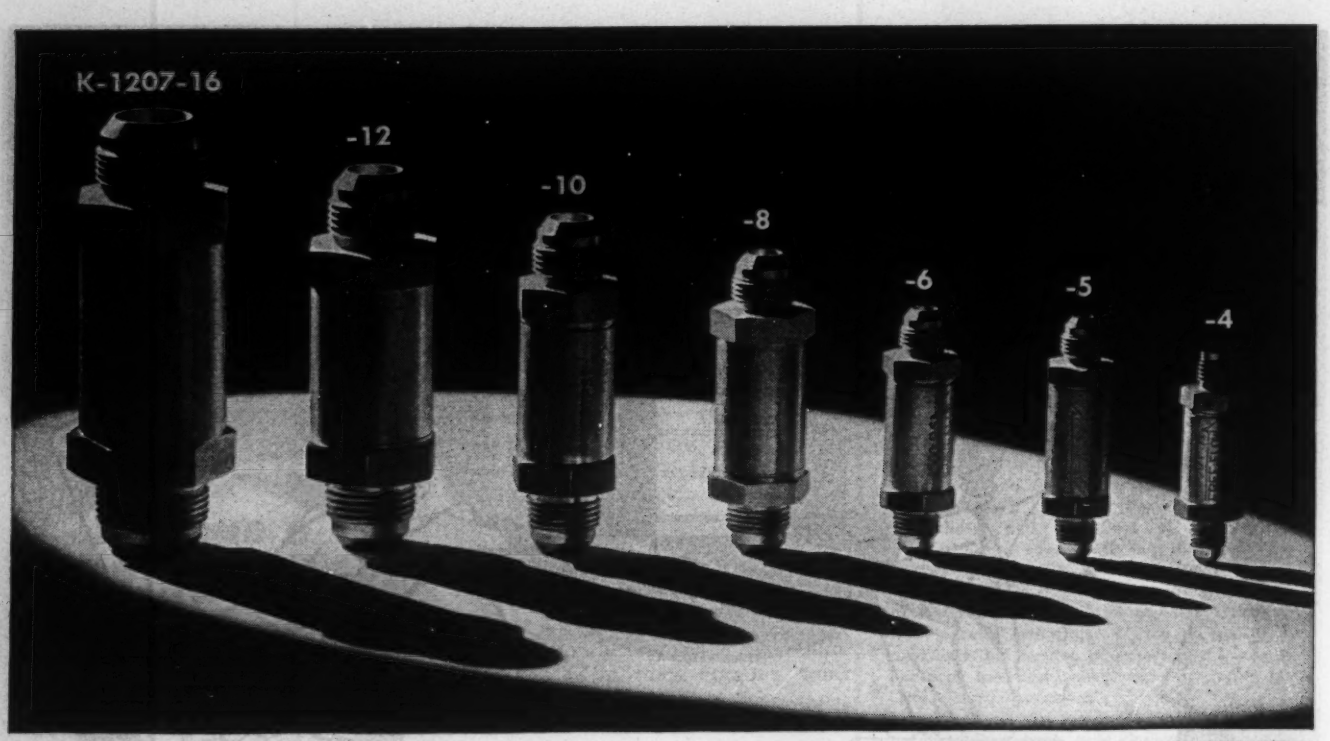
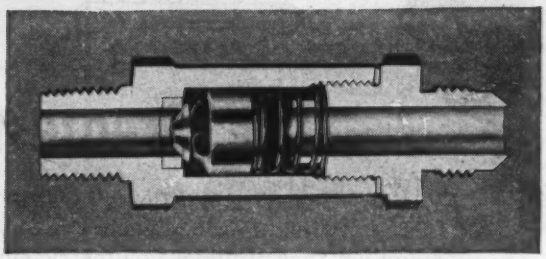
11610 Euclid Ave. · Cleveland 6, Ohio



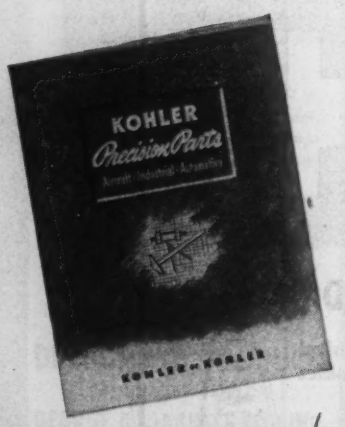
Cone-type check valves illustrated have an operating pressure up to 1500 PSI with a burst pressure of 3750 PSI. Excellent for use with hydraulic fluids, gasolines, oils, water, and acids non-corrosive to aluminum.



Metal-to-metal seats are best suited for high pressures, extreme temperatures, and corrosive fluids.

Specify KOHLER CHECK VALVES

for long service life



The complete line of Kohler Precision Parts includes check valves for all aircraft, industrial and automotive installations. Leading manufacturers specify Kohler valves for lines using hydraulic fluids, gasolines, lubricating oils, aromatic fluids, air, vacuum, water, acids, chemicals, etc.—and requiring a *pressure regulating valve, pressure relief valve, vacuum breaker, restrictor check, check valves with high or low opening pressures or check valves for special applications.*

All major types, cone, soft seat, and swing checks, have been developed to meet rigid service requirements. The superiority of Kohler designs and precision manufacturing processes have been demonstrated by valves in actual use. Kohler valves have quick opening and positive closing without poppet chatter or leakage. When they are open, free flow is maintained with minimum pressure drop.

Kohler engineers will gladly cooperate in developing precision parts for your special requirements. Write for our new catalog, showing the full line of Kohler Precision Parts, with specifications, engineering data and useful information.

SEND FOR THIS CATALOG TODAY

KOHLER CO., Dept. 18-J, Kohler, Wisconsin
Please send your new Catalog to:

Name.....

Company.....

Address.....

KOHLER OF KOHLER

PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS

Preventing END BEARING OF GEAR TEETH...

- increases their factor of safety
- reduces gear noise
- and prolongs service life

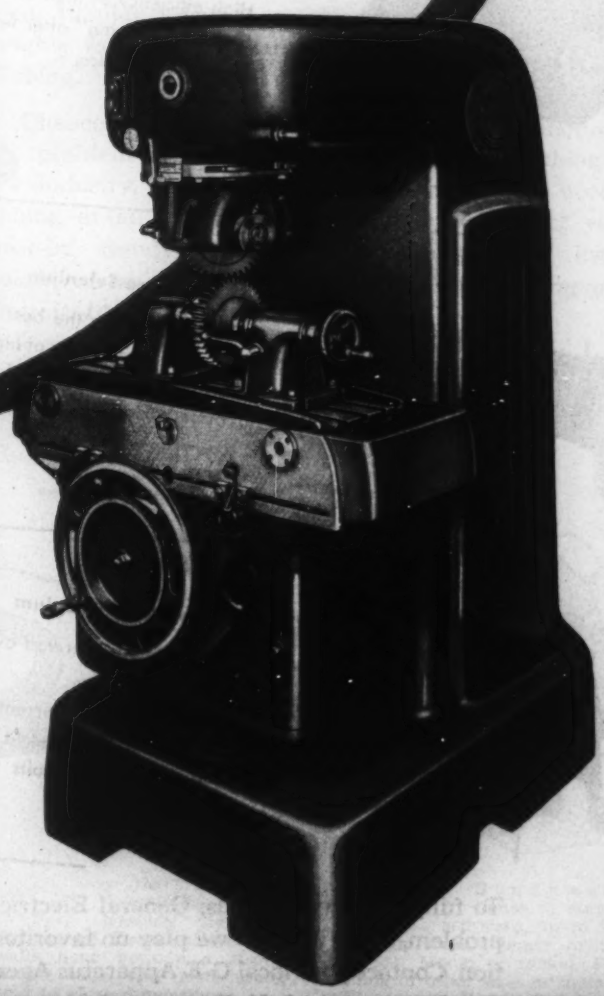
Conventional gear teeth (spur or helical) can be expected to behave as they should theoretically only on the drafting board. When they are made of steel and assembled in a power unit, it is a rare accident when bearing is uniform across the entire faces of any two mating teeth. In nearly every case bearing is concentrated at one end of the tooth or the other where it is most vulnerable to failure.

The remedy is the Elliptoid Tooth Form, engineered and produced by Red Ring engineers 12 years ago. The Elliptoid Tooth Form positively prevents end bearing as demonstrated by actual experience in hundreds of applications.

One nationally known manufacturer of trucks and tractors received frequent complaints of gear tooth failures until he adopted the Elliptoid Tooth Form. Since then such complaints have practically vanished. Elliptoid transmission gears tested by this manufacturer for 125 hours under a load of 140 foot pounds and then for an additional 125 hours at 180 foot pounds showed no harmful effects.

Another top ranking tractor manufacturer says the service life of his Elliptoid gears is 30 times greater than that of previous conventional gears. Elliptoid gears are produced on Red Ring Gear Shaving Machines.

Send for descriptive literature.



SPUR AND HELICAL
GEAR SPECIALISTS
ORIGINATORS OF ROTARY SHAVING
AND ELLIPTOID TOOTH FORM

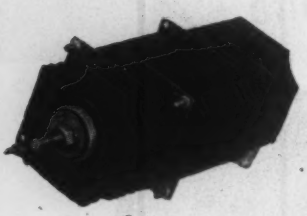
NATIONAL BROACH AND MACHINE CO.

5600 ST. JEAN • • • • • • • • • DETROIT 13, MICHIGAN

WORLD'S LARGEST PRODUCER OF GEAR SHAVING EQUIPMENT

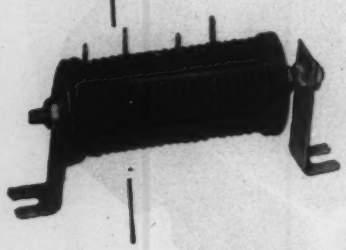
Pick the Rectifier to fit your need

Each of these three popular metallic rectifiers, copper oxide, low-voltage selenium, and high-voltage selenium, has its own characteristics which make it a better rectifier for a particular application. As the best choice depends on the desired application characteristics, here are some general characteristics:



	Characteristics	Application
Copper Oxide	Always formed blocking layer Heavy overload, voltage and current, of short duration High efficiency at high current densities Stabilized "aging" after few months Continuous service Long life	Blocking relays in control circuits Circuit breaker Plating equipment Exciter circuits Relay power supply Battery chargers

Low-voltage Selenium	Generally offers the best compromise between the features of high-voltage selenium and stability of efficiency of copper oxide.	Cathodic protection Magnetic separators Battery eliminators Elevator controls



High-voltage Selenium	Smaller in size per volt over 12 Light weight High voltage, low current Suitable for economical intermittent service over 12 volts	Calculating machines Aircraft Arc suppressor Coin machines

To fully meet your needs, General Electric makes all three types. If you have a rectifier problem, bring it to us—we play no favorites, we will give you an impartial recommendation. Contact your local G-E Apparatus Agent, or write *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

GENERAL ELECTRIC

436-17

Bundyweld*... your best call for tubing

Like to get a line on better design, faster production, lower costs or higher quality in your tubular applications?

Put in a call for Bundyweld* Tubing!

Double-walled from a single strip, bonded throughout, Bundyweld is lightweight, ductile . . . leakproof, too . . . and can be bent without fear of collapsing or weakening structurally. Held to close tolerances, it can be easily machined or fabricated . . . cuts production time, lowers production expense.

Manufacturers in many fields . . . automobile, machine tool, range, television, radiant heating, refrigeration, tubular toys—to mention only a few . . . are ringing in on the advantages of low-cost Bundyweld Tubing.

Chances are, your design, structural or functional problem can be solved by this miracle tubing of industry, even though you may not seem to need a tubing at all. Why not give it a try? Contact your near-by Bundy representative among those listed below, or write direct to: *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS

* REG. U.S. PAT. OFF.

WHY BUNDYWELD IS BETTER TUBING

1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.

2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.

3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.

4 Bundyweld comes in standard sizes, up to ⅜" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

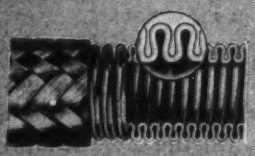
BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES

Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 404 Architects Bldg. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 3628 E. Marginal Way • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 881 Bay St.

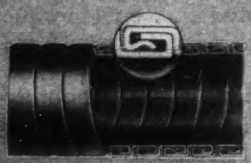
BUNDYWELD NICKEL AND MONEL TUBING IS SOLD BY DISTRIBUTORS OF NICKEL AND NICKEL ALLOYS IN PRINCIPAL CITIES.

CMH

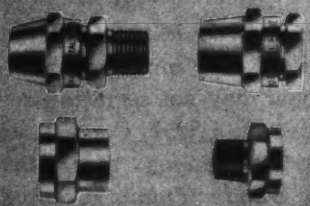
One dependable source for every flexible metal hose requirement



Corrugated Metal Hose in steel, bronze and stainless steel.



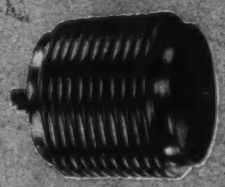
Convoluted Metal Hose in variety of types—steel, bronze and alloys.



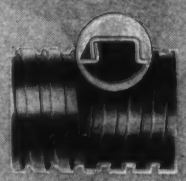
Couplings to meet every need.

CMH	HOSE USE
✓	Steam Hose
✓	Lubrication Hose
✓	Oil Lines
✓	Coolant Hose
✓	Pneumatic Hose
✓	Hydraulic Hose
✓	Chemical Hose
✓	Insulated Hose
✓	Charging Hose
✓	Expansion Joints
✓	Flexible Connections
✓	Exhaust Hose
✓	Platen Press Connections
✓	Tar and Asphalt Hose
✓	Metal Conduits
✓	Loading & Unloading Hose
✓	Gas & Air Hose
✓	Vacuum Hose
✓	General Utility Hose
✓	Bellows
✓	Flexible Lamp Arms

Expansion Joints for high and low pressures—stainless steel and copper.



Bellows in all sizes for all requirements—stainless steel and brass.



Metal Conduits in a variety of types and materials.

Now you can secure all your flexible metal hose needs from a single manufacturer. The handy check list above indicates only the more common types and assemblies manufactured by CMH. Other types and assemblies are also available. Bulletin 102, illustrated at the left, an application guide for CMH Flexible Metal Hose is available on request. Other literature giving full details on expansion joints, bellows and speciality items is also available. Write for your copies of the material in which you are interested and have it available for reference at all times.

Flexon identifies CMH products which have served industry for more than 47 years.

CHICAGO METAL HOSE CORPORATION

Maywood, Illinois

Plants at Maywood, Elgin and Rock Falls, Illinois

In Canada: Canadian Metal Hose Company, Ltd., Brampton, Ontario

THE GOOD RIGHT HAND OF INDUSTRY

Worthington CN Centrifugal Pump—its short oversize shaft means better service, longer life.

It's Versatile . . .

takes whatever drive is

handiest

Meet the "any-drive" pump—the new Worthington CN many-purpose Centrifugal that can be driven by the most convenient means available.

It's another general utility pump like the famous Monobloc—but without the motor. The liquid end is mounted on a frame, from which the shaft extends to be coupled to a motor, fitted with V-belt sheave, or what have you. In an emergency, you can quickly shift to another type of drive.

It's *rugged*—designed for overhung pulley-drive—rigid shaft maintains perfect alignment of pump parts. It's *flexible*—use interchangeably either packed stuffing box or mechanical seal.

More Pumps "Across the Board"

Worthington makes all types, all sizes of standard pumps. When you reach the point of specifying a pump for your equipment, remember that no company offers more pumps—no company offers more value in pumps—than Worthington. Send coupon for free bulletin showing why, in pumps, *there's more worth in Worthington.*

WORTHINGTON

WORTHINGTON PUMP AND MACHINERY CORPORATION
PUMP AND COMPRESSOR MERCHANDISING DIVISION
HARRISON, NEW JERSEY

The Good Right Hand of Industry

POWER TRANSMISSION: sheaves, V-belts, variable speed drives
PUMPS: centrifugal, power, rotary, steam
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Worthington Pump and Machinery Corp.
Pump and Compressor Merchandising Div.
Harrison, N. J. Dept. PCA919

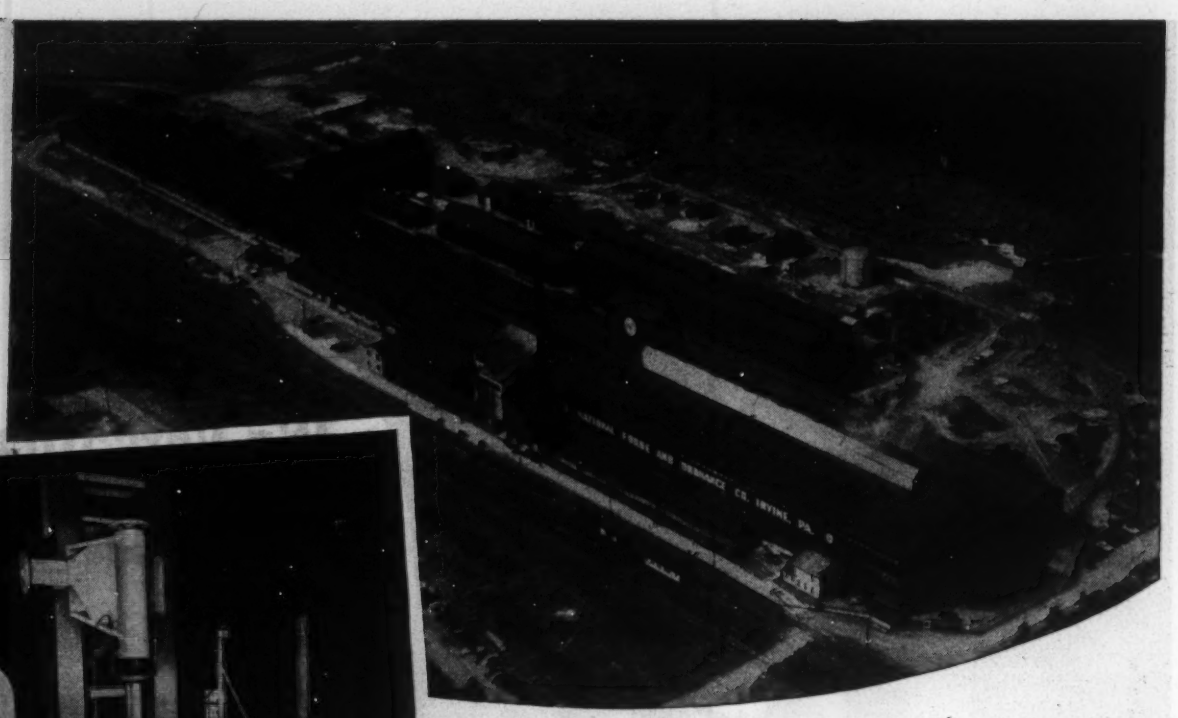
☐ Send latest bulletin on Worthington Centrifugal Pumps. Any other (type).....

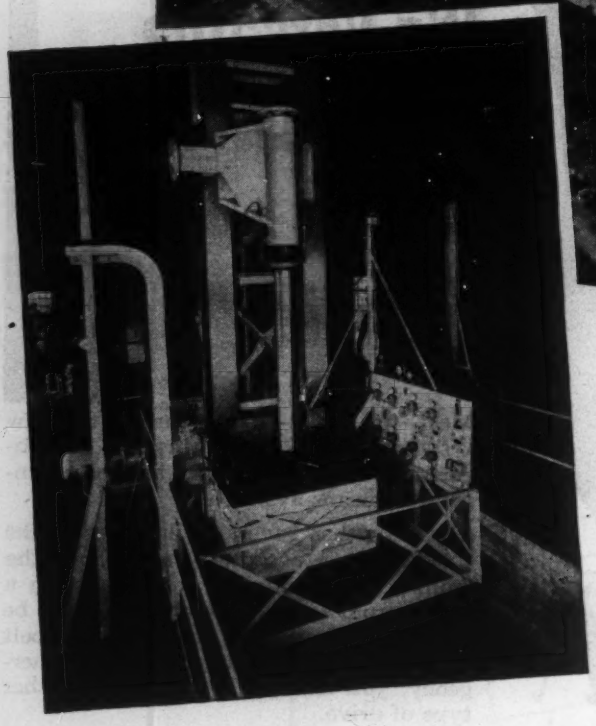
Name.....

Company.....

Address.....

PCD-19





Now...

YOU CAN HAVE YOUR HEAVY FORGINGS FLAME HARDENED AT NATIONAL FORGE

New, Flame Hardening Equipment with a capacity of from 4″ to 18″ in diameter and up to 20 feet in length makes it possible for you to realize the same advantages and economies of flame hardening your heavy forgings as was formerly possible only with smaller pieces.

Flame Hardening produces a uniform surface hardness to a depth of 1/16 to 3/8 inch as required, leaving the core of your forgings unaffected. This means that previous to flame hardening the forging may be treated to give the best physical core characteristics for its intended use. The flame hardening process is adaptable to all or a part of the surface, permitting the economy of hardening only the necessary areas.

In some cases carbon steel may be substituted for more costly alloy steels with better end results. The finest steel, electric steel, made at National Forge is forged and rough machined by experts, heat treated and flame hardened under strict laboratory control and finish machined to your exact specifications. The entire procedure of making the forging and flame hardening is under one responsibility.

We would like to talk over your forging needs with you and explain the benefits and economies of the Flame Hardening process and its possible applications to your needs. Why not get in touch with us now on this new Flame Hardening application?

NF

National Forge

AND ORDNANCE COMPANY

Irvine, Warren County, Pennsylvania

STEEL MAKERS ☆ FORGESMITHS

HEAT TREATERS ☆ MACHINISTS

Farval eliminates one oiler per shift, saves $34 a day

DUE to inadequate lubrication, the big 21" x 6" eccentric bearings on the shaker screens at a West Virginia tipple usually wore out in less than 90 days. The company switched from grease cups to grease guns, and then resorted to oil with various types of reservoirs. Still they couldn't get adequate lubrication. The maximum bearing life obtainable was only 3 to 4 months. Bearings had to be sent away for rebabbitting at $200 each. Even after the company equipped its own shop to do the work, rebabbitting expense was $75 per bearing.

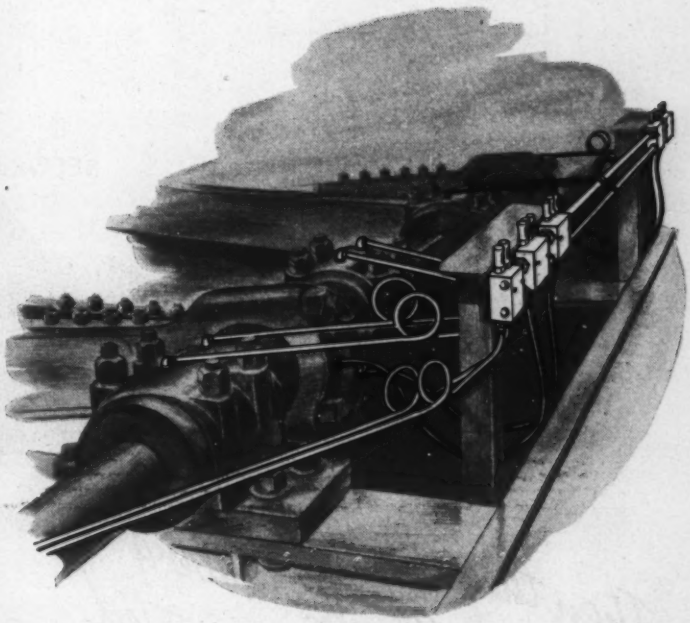
Then a Farval Centralized Lubricating System was installed. Serving 25 points, it has been in continuous operation, 24 hours a day, for 4½ years. Only one eccentric has been replaced and that was a badly worn bearing which went out a short time after Farval was installed.

Even more impressive dollar-wise is the reduction in labor. It used to be necessary to employ two hand oilers per shift. Now one man easily does all the lubrication work, with a consequent saving of $34 per 24-hour day—over $10,000 a year.

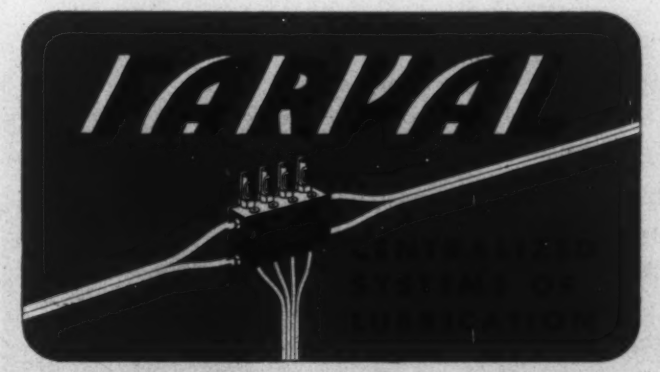
Farval centralized lubricating systems have been serving the coal industry for more than 19 years. Farval is the original Dualine system of centralized lubrication. The Farval valve has only 2 moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its wide valve ports and full hydraulic operation, Farval delivers a measured charge of grease or oil to each bearing, with an indicator at every bearing to show that each valve has functioned.

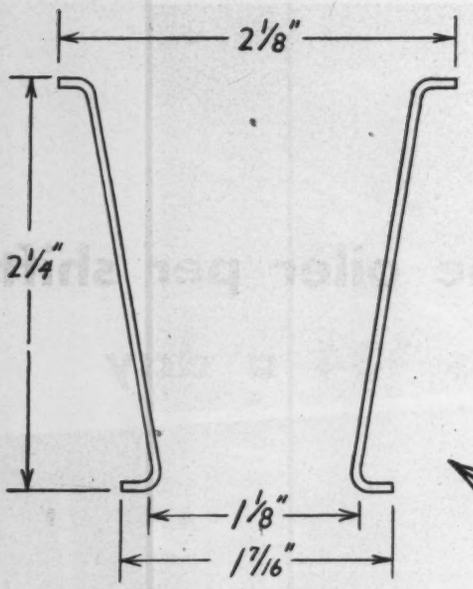
For a full description, write for Bulletin No. 25. The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing.
In Canada: Peacock Brothers Limited.

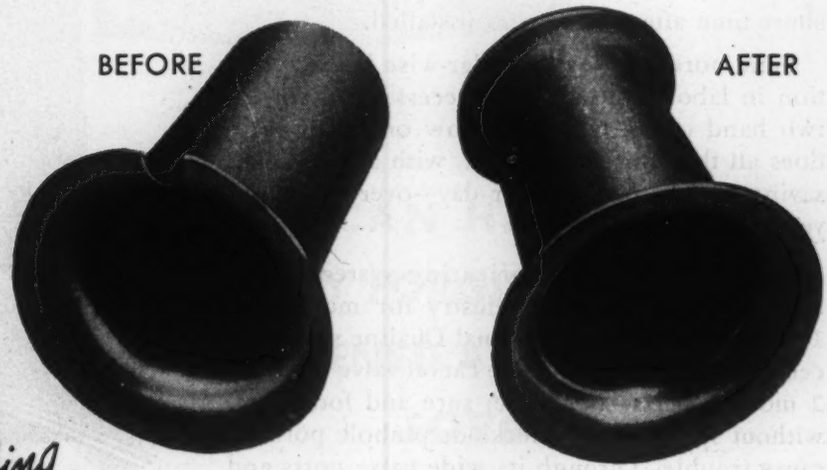


FARVAL—*Studies in Centralized Lubrication No. 96*





First they tried two makes of Type 304 Stainless Tubing, and got 50% rejects on the job.

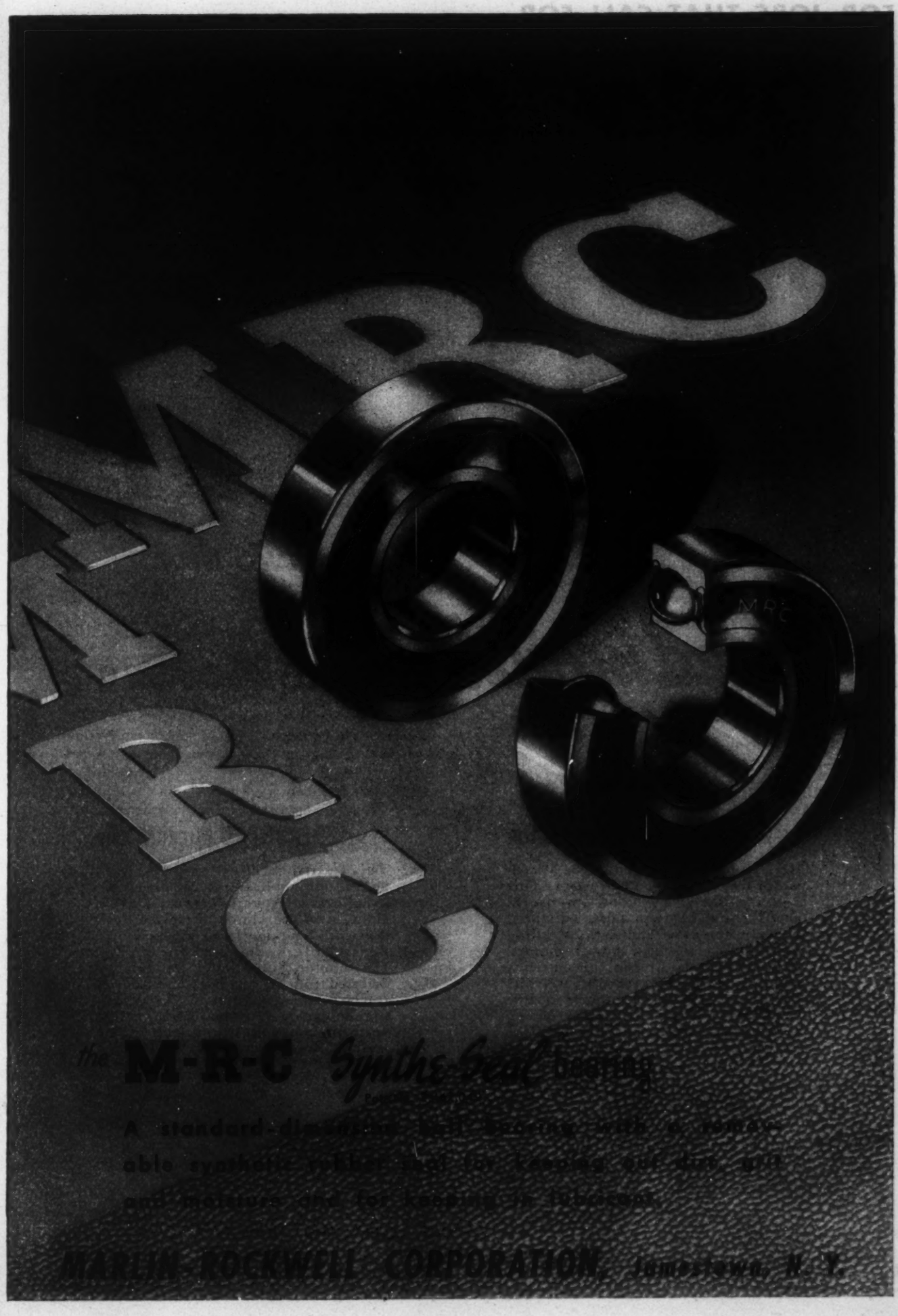


Then they changed to Carpenter Stainless Tubing (Type 304) and eliminated the high cost of rejects and making more parts than were ordered.

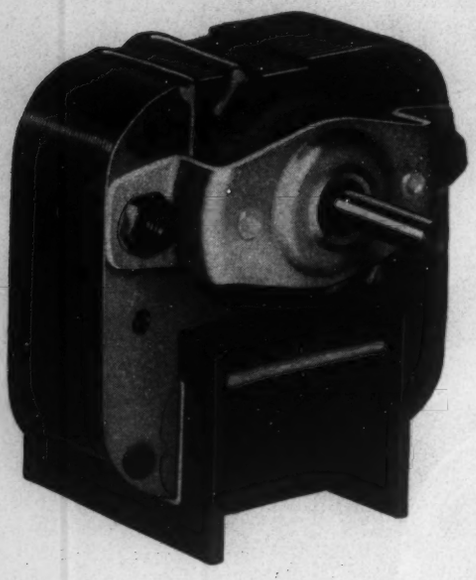
To prove to your own satisfaction that you can save money today by using Carpenter Stainless Tubing, drop us a line and put our experience to work on your jobs.

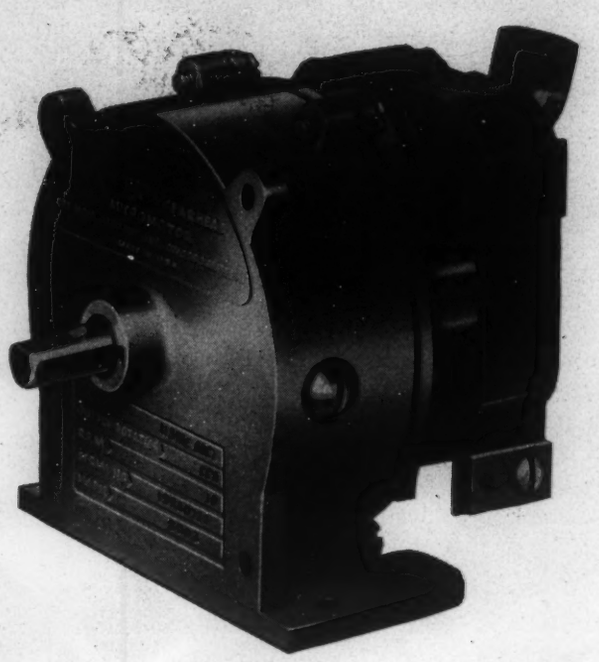
This useful Stainless Tubing file is yours for the asking. A note on your company letterhead will bring you this 12-page file of engineering data.

The Carpenter Steel Company, Alloy Tube Division,
115 Springfield Road, Union, N. J.


M-R-C
the M-R-C Synthe-Seal bearing
MARTIN-ROCKWELL CORPORATION Jamestown, N. Y.

FOR JOBS THAT CALL FOR TOP PERFORMANCE





HERE ARE TWO NEW

Redmond MicroMotors

2-POLE OFFSET MicroMotor

Here's a low cost, skeleton-type Micromotor that is a rugged performer. This 2-pole offset unit is ideal for use in small room heaters, fans, animated displays, and other applications calling for light weight, low power motors. Features include air gap concentricity, sturdy bearing brackets, oil reservoirs packed with felt, and highest quality enameled windings. Two holes in field laminations facilitate mounting. Built in sizes up to 1/100th horsepower.

GEARHEAD MicroMotor

This sturdy, quiet-running gearhead unit is for applications requiring unusual r.p.m. specifications. Output selections are almost without limit down to 2 r.p.m. It is powered by a dependable Redmond 2-pole offset Micromotor with a single bearing lubricated from the gear box. Brake device can be supplied if required. Four mounting holes are provided horizontal to shaft on front surface and four vertical to shaft on base surface.

Redmond COMPANY, INC.

OWOSSO, MICHIGAN

Offices in New York, Chicago, Los Angeles, Dallas

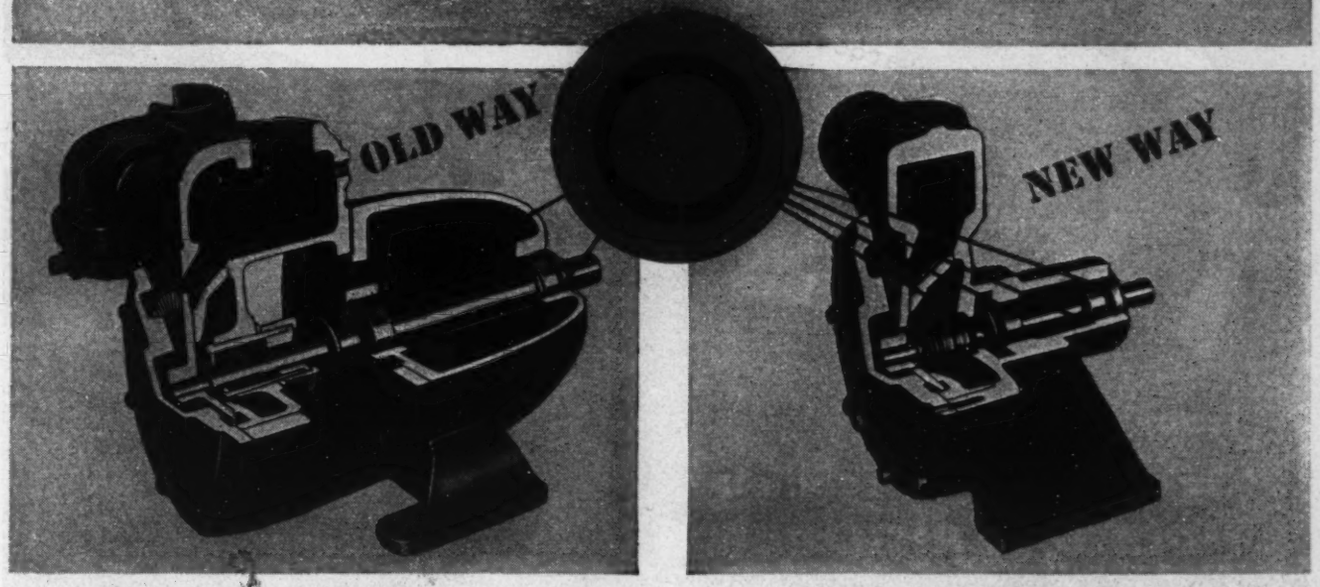
Expanded Facilities • Prompt Deliveries • Service before and beyond the sale

REDMOND ©

OVER 150 STANDARD MODELS

25 DIFFERENT TYPES

REDESIGN TRIMS LENGTH 5¼ INCHES, CUTS UNIT COST $5.70



Series D Wayne water pump uses machined shoulders to position bearings on shaft. 2 Truarc rings hold bearings in housing. Locknut holds screw-type stuffing box that requires periodic tightening.

New design uses 4 Truarc Inverted rings (2 external, 2 internal) to position shaft, retain bearings. Inverted rings provide shoulders of uniform section height. 1 Standard ring secures maintenance-free mechanical seal.

Redesign with Truarc Rings helps save $5.70 per unit for Wayne Home Equipment Company, Inc., Fort Wayne, Ind. It gives them a more compact product, eliminates a separate bearing pedestal and a skilled-labor grinding operation. It facilitates use of maintenance-free mechanical seal instead of old type stuffing box.

Redesign with Truarc Rings and you too will cut costs. Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins, there's a Truarc Ring that does a better job of holding parts together.

Truarc Rings are precision engineered. Quick and easy to assemble, disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

REDESIGN WITH 5 TRUARC RINGS GIVES THESE BIG SAVINGS

- *Cuts length 5¼ inches*
- *Cuts total labor 15.3%*
- *Eliminates skilled-labor grinding operation*
- *Saves 38.3% materials*
- *Allows use of stock-size shaft, smaller bearings*
- *Eliminates separate bearing pedestal*

TOTAL UNIT SAVING . . . $5.70

WALDES TRUARC

REG. U. S. PAT. OFF

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,302,948; 2,406,484; 2,416,852 AND OTHER PATS. PEND.

Waldes Kohinoor, Inc., 47-16 Austel Place MD-111
Long Island City 1, N. Y.

Please send 28-page Data Book on Waldes Truarc Retaining Rings.

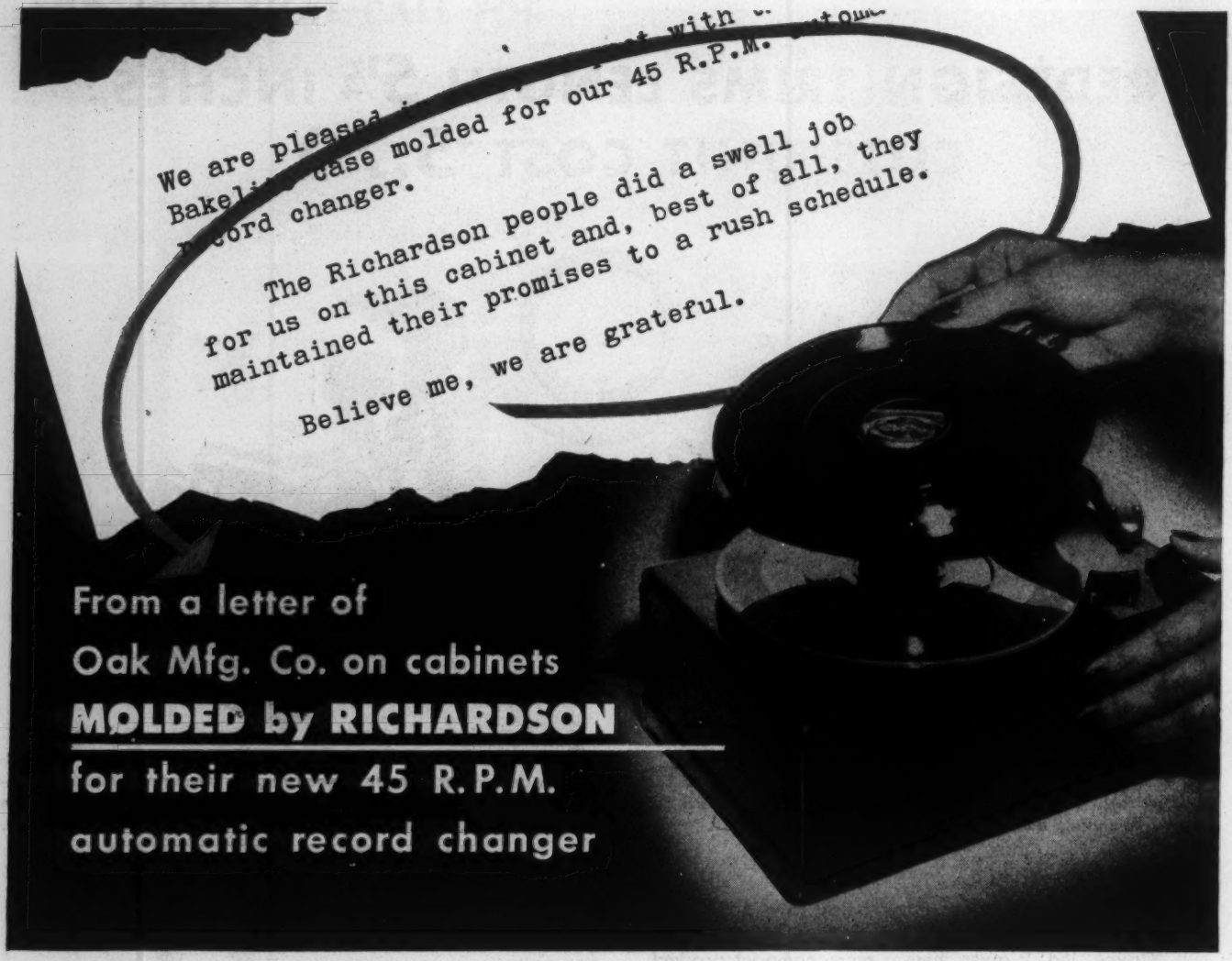
Name_____

Title_____

Company_____

Business Address_____

City_____ Zone_____ State_____ ★



RICHARDSON MOLDING SERVICES

This sturdy record changer cabinet, molded by Richardson for Oak Mfg. Co., is only one of thousands of parts Richardson has molded efficiently, economically and on time for scores of manufacturers.

These cabinets come from the molds with a smooth, attractive finish that makes further finishing operations unnecessary.

Richardson experience in molding plastics produced this cabinet with tapped machine screw holes accurately spaced for quick, easy assembly. Also, Richardson experience pointed the way to produce the job at minimum cost.

Hundreds of manufacturers have found that Richardson's extra experience, extra facilities and extra know-how have paid important dividends. May we discuss with you your next plastic molding job?

INSUROK by RICHARDSON
Dependable names in plastics

The RICHARDSON COMPANY
GENERAL OFFICES: LOCKLAND, OHIO FOUNDED IN 1858
Sales Headquarters: MELROSE PARK, ILLINOIS

CLEVELAND • DETROIT • INDIANAPOLIS • MILWAUKEE • NEW BRUNSWICK, (N. J.) • NEW YORK • PHILADELPHIA • ROCHESTER • ST. LOUIS

Wichita City Library

wherever connectors must move

Photos courtesy Connecticut Railway & Lighting Lines.

Air-line piping for motorbus brakes and doors takes constant punishment from movement and vibration. In the piping illustrated here, American Seamless Flexible Metal Tubing provides safe, *flexible* connectors that can bend freely as the piping moves and vibrates.

There is a type and size for carrying fluids, steam, semi-solids, or gases. If yours is a special problem, American engineers offer you their long years of varied experience in connector applications.

For complete information on American Flexible Metal Hose and Tubing, write for literature. Address your inquiry to The American Brass Company, American Metal Hose Branch, Waterbury 88, Connecticut. In Canada, The Canadian Fairbanks-Morse Co., Ltd.

49232

ANACONDA American

flexible metal hose and tubing

ANNOUNCING!

A New Line of Sundstrand Panel Mounted Hydraulic Valves - - -

redesigned to
J.I.C. Standards

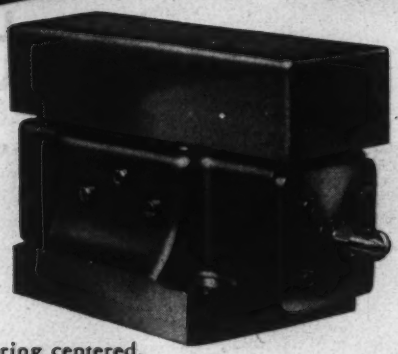
For efficient operation and simplified installation, use these new Sundstrand valves for hydraulic (oil) circuits. They have been redesigned to meet the exacting requirements of the Joint Industries Committee standards but are based on many years of experience in the design and manufacture of hydraulic valves and equipment. Sundstrand valves are available in a range of piping sizes up to ¾" for panel or gasket mounting.

The line of Sundstrand valves now includes the following:

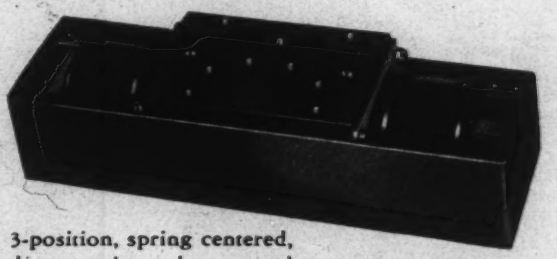
- Relief Valves (High and Low Pressure Series and Non-Adjustable)
- Solenoid Operated Pilot Valves
- 4-Way Valves (Manual, Mechanical, Solenoid Pilot Operated and Hydraulic Pilot Operated)
- Sequence Valves
- Counterbalance Valves
- Cycle Valves
- Blocking Valves
- Loading and Unloading Valves
- Check Valves
- Solenoid Operated Valves

FREE DATA

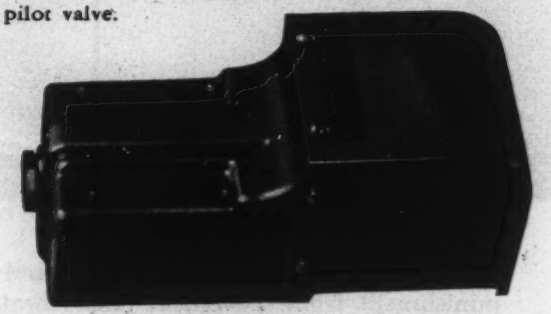
Complete engineering data sheets on the above valves are available. You'll simplify circuit design and improve product performance with these efficient valves. Write for bulletin M-47.



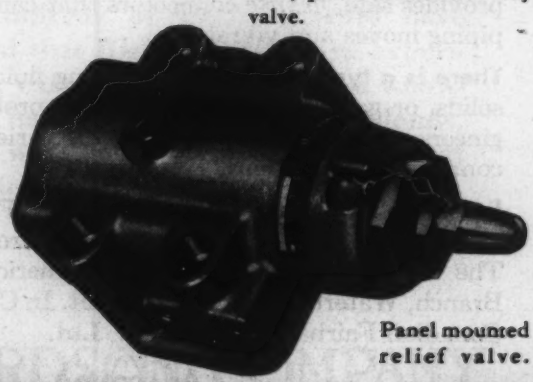
3-position, spring centered, solenoid operated 4-way valve.



3-position, spring centered, direct solenoid operated pilot valve.



2-position, solenoid operated, panel mounted 4-way valve.



Panel mounted relief valve.

SUNDSTRAND MACHINE TOOL CO. ROCKFORD, ILLINOIS, U.S.A.

SUNDSTRAND HYDRAULIC DIVISION

2559 ELEVENTH STREET • ROCKFORD, ILLINOIS

FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS

Story of the two "missing days"

Back in 1910, when a man left his home on Monday morning, he had a 58-hour work week before him.

But over the years—as workers, business and manufacturing methods all got more efficient—it took less and less working time to produce goods of all kinds.

The result is that today the average work week has been cut to 40 hours. 18 hours—more than two whole working days—are missing from a man's work week. They've been transferred to the man himself—to use for leisure time!

But that's not the whole story. Back in 1910, the average household earned about $2400 for its year's work. Today, for a lot less work, it earns nearly *twice* that! And in dollars of the same purchasing power, too.

That's the American economic system at work.

This system has some faults—such as ups and downs in prices and jobs. And everybody in this country, except a small group of eccentrics and communists, is working to correct them.

But just remember this: If you want to earn still more money—if you want to work still shorter hours—the only way to do it is to make the American system work even *better*. And that means that every man, every business, every machine has got to produce more and more for every hour they work—just as they've *been* doing since 1910. And if they do, the gains can be shared by everyone.

All of us in this country *want* the system to work better. And if all of us work together—you can be dead sure it *will*.

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BORIS SHISHKIN, Economist, American Federation of Labor
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This advertisement is therefore published as a public service by:

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Approved by representatives of Management, Labor and the Public.

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—How we have been able to raise wages and shorten working hours
—Why the mainspring of our system is productivity
—How a still better living can be had for all

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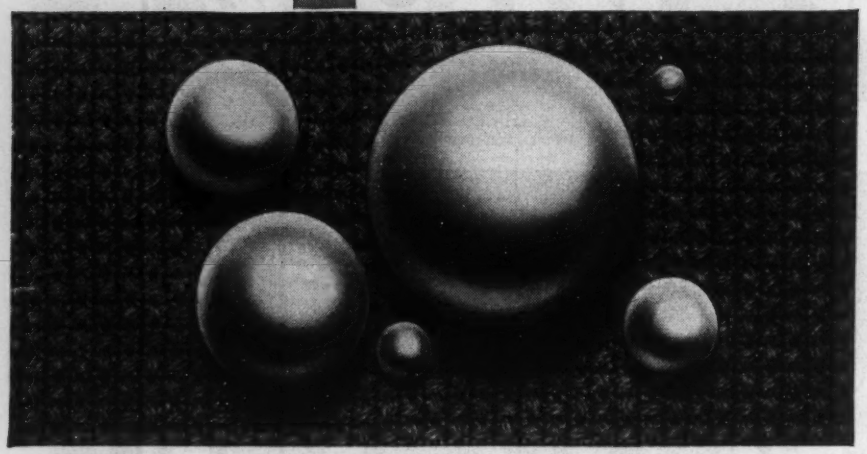

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And the service results from every Strom metal ball prove it—not only in the finest precision ball bearings but also in the lot of other ball applications where Strom balls are doing the job better.

Strom has been making precision metal balls for over 25 years for all industry and can be a big help to you in selecting the right ball for any of your requirements. In size and spherical accuracy, perfection of surface, uniformity, and dependable physical quality, there's not a better ball made.

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Largest Independent and Exclusive Metal Ball Manufacturer

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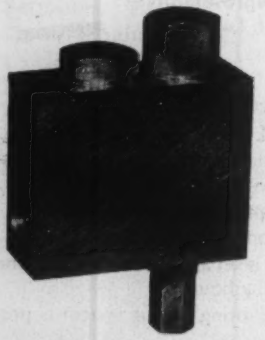
Constant Pressure
ADJUSTABLE
"Pilot" Type RELIEF VALVES
FOR OIL



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LIST PRICE
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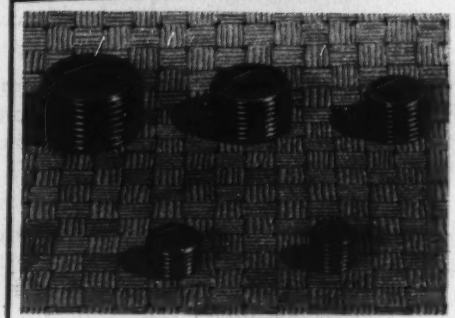
- Constant Relief Pressure—Unaffected by Flow, Temperature, or Viscosity.
- No Leakage at 90% of Full Relief Pressure.
- For Oil Pressures of 50 to 4,000 P.S.I. (Specify Pressure Range and Setting Desired.)
- Other Models Available in ½ and ¾ Pipe Sizes.

FLUID CONTROLS, INC.
P. O. Box 186 A
WILLOUGHBY, OHIO

TOUREK announces its new line of PRECISION-MADE
STEEL PIPE PLUGS



Accurate . . . High Strength . . . Economical!
Tourek's new line of standard countersunk pipe plugs gives you the favorable physical characteristics of specially selected steel in combination with precision automatic screw machine production—resulting in the highest quality at costs which are competitive to old style plugs.

Standard stock sizes, available with National Pipe or Dry-Seal threads are: ¼", ⅜", ½", ¾" and 1".

Tourek pipe plugs are available on special order in alloy steels, aluminum or brass in sizes up to 2⅜" diameter.

Send today for literature which gives complete specifications.

J. J. TOUREK MFG. CO.
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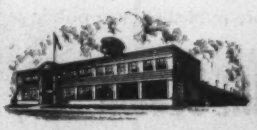

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ESTABLISHED 1920
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FAMOUS BALL JOINTS

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Preventing aircraft failures tomorrow depends on knowing exactly what causes them today. That's why so many modern planes carry a sure-to-survive witness that tells what mechanical malfunction betrayed the pilot's skill. It's the amazing new Flight Recorder that charts a continuous log of the variables that might cause a crash.

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The heart of this pilot's loyal supporter is a Telechron Timing Motor . . . *instantly, constantly synchronous.* Only such an accurate, trouble-free motor could be trusted to time the chart that shows the aircraft industry's planners how to add ever-increasing safety to the age of flight.

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You, too, can control or record your variable factors with the ultimate in accuracy. Just call in a Telechron application engineer. Drawing on the broadest experience in the industry, he can probably show you how a standard Telechron motor can do your job. Consult him early in your planning for big savings in time and money. TELECHRON INC. A General Electric Affiliate.

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FOR AIR CYLINDER CONTROL
FULL FLOW • COMPACT • ONE MOVING PART
PRECISION SPOOL AND BORE THAT IS
HARD CHROME PLATED FOR EXTRA LIFE
BALANCED TYPE "AIR PRESSURE SEALED"

TWO BASIC
PIPE SIZES
3/8" - 3/4"

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Standard WASHERS

PRESS ON . . .
quick, positive assembly.

CLAMP SHUT. . .
360° closure supports greater thrust loads.

OPEN . . . PULL OFF. . .
fast, easy removal simplifies service and repair.

Available for pin diameters—
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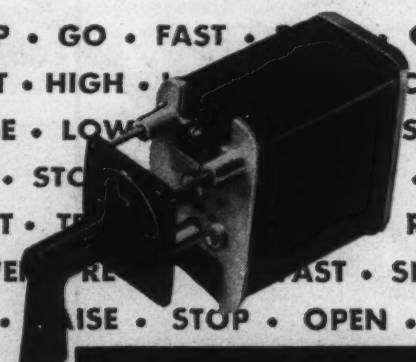
OPEN •



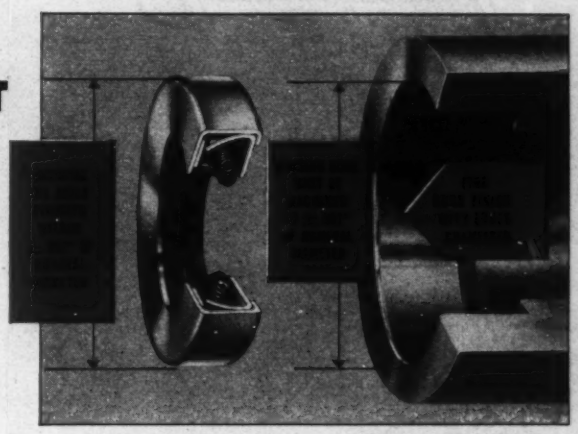
CHOOSE AN SB-1 SWITCH
FOR YOUR CONTROL JOBS

You can use this sturdy, versatile control and transfer switch on practically any circuit for practically any job—over 10,000 circuit-sequence combinations are possible. Rated up to 20 amperes at 600 volts a-c or d-c; and standards are ready on four weeks delivery. Easy to order, too. Mount on panels 1/8 to 2 inches thick. Switch shown is 8 1/4 inches overall, 2 3/4 inches wide, 4 1/4 inches high. See your G-E sales representative and write for bulletin GEA-4746. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

NATIONAL OIL SEAL LOGBOOK

CORRECT PRESS-FIT NECESSARY FOR EFFICIENT OIL RETENTION



It is obvious that a metal-encased oil seal, no matter how well designed and carefully manufactured, will not perform efficiently unless installed in an accurately machined bore. Yet, many times it is true that proper care is not exercised during course of production to prepare the housing bore to accurate press-fit tolerance.

To achieve a good seal at the O.D. of a metal-encased oil seal, it is necessary to machine the bore to ± .001" of the nominal oil seal diameter. This bore should also be chamfered at outer edge to prevent shearing of the oil seal case. The finish of the machining should be as fine as practicable so as to eliminate the possibility of scratching the oil seal case as it is pressed into the housing. Even small scratches can result in bad leakage around the outer periphery. In production, National metal-encased oil seals are gauged to within ± .002", which will provide an effective closure in the properly machined bore. In extreme cases special adhesives are sometimes employed to insure closure between oil seal and housing bore.

NATIONAL RUBBER-COVERED SEALS REQUIRE LESS CRITICAL BORE

Section of typical National rubber-covered oil seal. Note thin rubber section at O.D. and rigid steel truss frame.

Newly developed National rubber-covered oil seals may make possible important savings in machining and assembling costs. They are soft and flexible enough to form a perfect closure between the O.D. of seal and the housing bore, even allowing for minor flaws in the finish. However, these seals must be built upon a rigid steel truss frame with a minimum of rubber on the O.D. so as to maintain accurate O.D. dimension and fit under all operating conditions.

National engineers are anxious to help you with any oil or fluid retention problems. For further information contact nearest office or write direct.

NATIONAL
OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, Calif.
Plants: Redwood City and Los Angeles, Calif.; Van Wert, Ohio

1949

CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS

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CLEVELAND: 210 Heights Rockefeller Bldg., Yellowstone 2720.
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MILWAUKEE: 647 West Virginia St., Marquette 8-8986.
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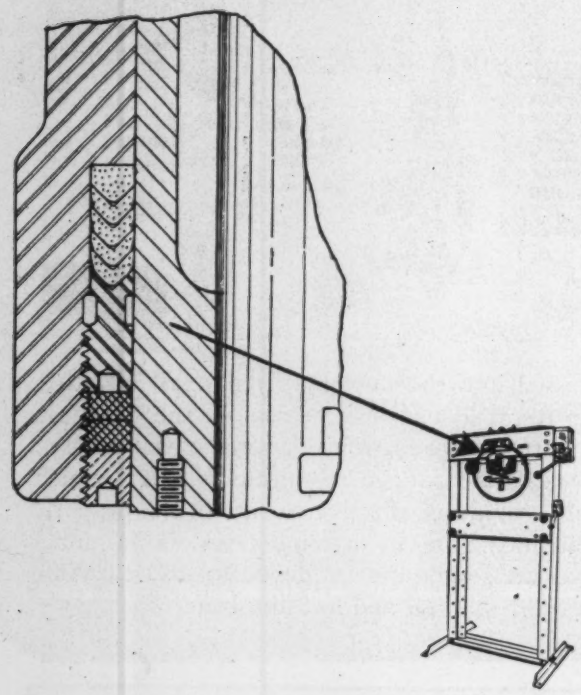
PACKED WITH POWER... PACKING BY LINEAR



American Chain & Cable's popular Manley 40 ton hydraulic press, made for rough treatment and long use, is featured with a packing assembly built for trouble-free service!

To assure maximum efficiency and uniform pressure maintenance for the entire unit, Manley engineers specified Linear V-type packings for this compact packing installation. *Automatic—self-sealing—Linear V packings seal from zero to peak pressures, reducing wear and frictional drag to a minimum.* And note in the packing design, how wiping rings are used to prevent dirt and grit from working into the packing. No wonder this packing installation puts money in your pocket with lowered maintenance cost!

This is only one of many thousands of applications where Linear homogeneous or fabric-reinforced V-type packings are sealing against air, steam, water, gas, oils and solvents over a wide temperature range. If you wish to design your packing assembly for lower costs and more efficient operation, specify a quality packing—SPECIFY LINEAR V-RINGS!

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA

2 Engines are Better than 1

This NEW Vegetable Harvester Is Powered by 2 WISCONSIN Heavy-Duty Air-Cooled ENGINES!

Harvesting onions and other vegetables mechanically is a NEW idea for a NEW machine . . . The Dilts-Wetzel (Ithaca, Mich.) Vegetable Harvester, powered by TWO Wisconsin Heavy-Duty Air-Cooled Engines... one driving the unit... the other powering the harvesting mechanism.

Peak efficiency and flexibility are always delivered, because the harvesting engine operates at uniform speed, regardless of the forward travel speed, and it shuts down entirely when moving to new locations. Furthermore, TWO Wisconsin Engines weigh less, cost less, use less fuel, and have lower part replacement costs than one large engine of comparable total horsepower.

Perhaps this offers an idea that can be advantageously applied to your equipment — for greater power, flexibility, efficiency, and economy. Your investigation is invited.

2 to 30 hp., single-cylinder, two-cylinder, and V-type four-cylinder models.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 14, WISCONSIN, U. S. A.

Cable Address: WISMOTORCO

"VALVAIRS" are Dependable

All types of manually and mechanically operated valves are also available.

- "OU" TYPE PACKER.
- STANDARD PIPE SIZE AREA THROUGH VALVE.
- HEAVY SOLENOID GIVES POSITIVE ACTION AND COOL OPERATION.
- FOR AIR, WATER, OIL AND VACUUM USE ON PRESSURES UP TO 150 LBS. P.S.I. AND TEMPERATURES UP TO 120° F.

2-WAY; PIPED EXHAUST—3-WAY, 4-WAY

3-way piped exhaust double solenoid-operated valve.

Ask For Folder "S-D."

VALVAIR CORPORATION • 454 Morgan Avenue, Akron 11, Ohio

AFFILIATE: SINCLAIR-COLLINS VALVE CO.

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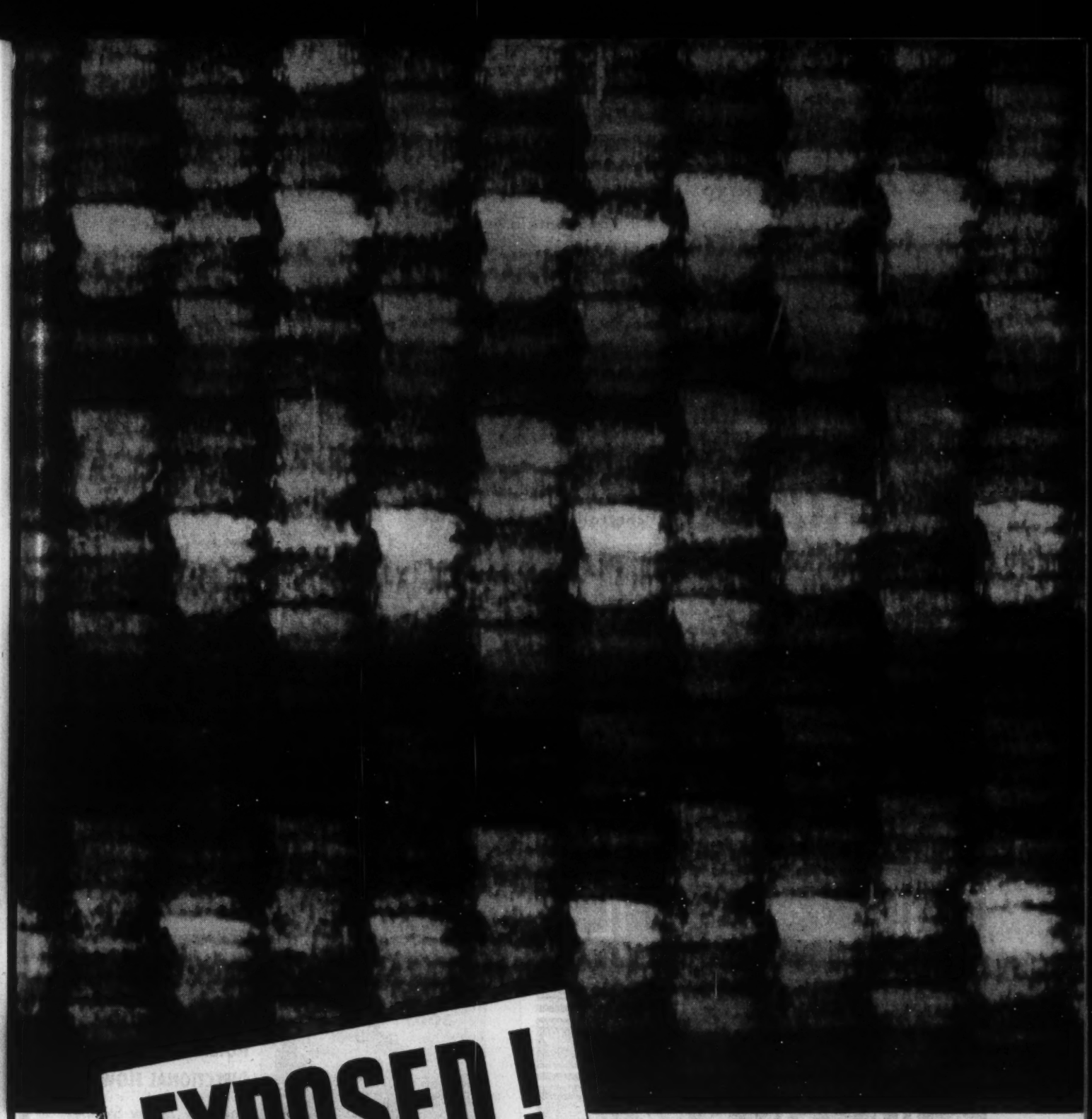

EXPOSED!

by SUPERFINISH

Here, in an enlargement of a 3/4" section, you see the grinding defects —*chatter and feed marks*—left on a ground surface which was previously considered acceptable. Partial Superfinishing shows them up. Complete Superfinishing will remove them . . . and produce a bearing surface which will last infinitely longer.

Superfinishing is a quick and inexpensive process which more than pays for itself in better performance, longer life and reduced service problems. The booklet, "Wear and Surface Finish," will be sent upon request. Please use your company letterhead.

GISHOLT MACHINE COMPANY

Madison 10, Wisconsin

THE GISHOLT ROUND TABLE represents the collective experience of specialists in machining, surface-finishing and balancing of round and partly round parts. Your problems are welcomed here.

TURRET LATHES • AUTOMATIC LATHES • BALANCERS • SUPERFINISHERS • SPECIAL MACHINES

Fluid Power Improves Production

"LOGAN" AIR-DRAULIC® FEED-CONTROLLED CYLINDERS

- Power Movements in Any Direction
- No Power Unit Required

5 STANDARD MOUNTING TYPES

Foot • Center Line • Blind End Flange • Rod End Flange • Clevis

Standard bores from 3" to 8" Any stroke to 5' For air pressures to 150 p.s.i.

Combines

the fast-acting, economical, low pressure operation of **AIR** with the smooth, uniform controlled regulation of **OIL**

***ENGINEERING SERVICE:** Consult our engineers regarding type of cylinders best suited to your needs. No obligation.

Logan Air-Draulic Cylinders provide far more accurate, uniform action than any ordinary air cylinder. They can be furnished for controlled feed with rapid return in either direction, or with controlled feed in both directions. Skip feed movements can also be provided by means of a cam valve in the hydraulic circuit.

FREE CATALOG Write for your free copy of catalog No. 471. Contains full engineering data and diagrams.

Logan SAVES TIME EFFORT MOTION

LOGANSPORT MACHINE CO., INC. 311 Center Ave. Logansport, Ind

FLUID POWER SPECIALISTS SINCE 1916

You CAN Transmit Power Better—with

POWER TAKE-OFFS

ROCKFORD CLUTCHES

Millions of power-driven vehicles and machines are operating more efficiently than was calculated in their original specifications — by using ROCKFORD clutches that are exactly suited to their particular needs. A ROCKFORD engineered-for-the-job application may be the means of improving the operation of your product. Certainly it will pay you to investigate the possibility. During the past quarter century, ROCKFORD has accumulated a fund of useful information about the transmission and control of power thru clutches. This know-how is available for the use of your engineering department, upon request.

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A New Solenoid Valve THREE-WAY

NORMALLY OPEN
NORMALLY CLOSED
DIRECTIONAL FLOW

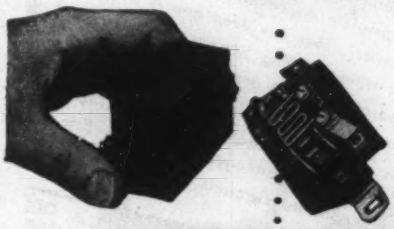
The new 3-way Skinner Diaphragm Type Valves have full 3/8" orifice and 3/8" or 1/2" N.P.T. ports. All metal internal parts are brass or stainless steel. Soft synthetic inserts prevent leakage—pilot is spring loaded for positive action—diaphragm is tough coated nylon fabric for long life—valve weighs 3¾ lbs.—maximum power consumption, 10 watts. Designed for continuous or intermittent duty with petroleum oils, kerosene, gasoline, water, air and inert gases from 20 to 150 p.s.i. Small in size—large in capacity.

Write today for new free Bulletin No. 493 giving complete data on models and prices.

Skinner ELECTRIC VALVE DIV.
THE SKINNER CHUCK COMPANY
133 Belden Ave., Norwalk, Conn.

INCREASED VALUE

no increase in price



manual motor starters...

.... feature quick, easy installation; positive overload protection with long-life bi-metallic relays; easy wiring and servicing because terminals are wired from the front. Application—fractional and integral motors up to 7½ horsepower.

The CR1061 controls a handkerchief ironer in a modern laundry.

The CR1062 is easy to mount and wire. Used here on a coolant pump.

Roomy, attractive case can be mounted on or beside the machine. Sturdy switch mechanism resists vibration. New push-button as well as toggle-type forms now available for integral motor starting. All forms—watertight, dust-tight, and explosion-proof—available in both lines. Write now for more information. *Remember, these new starters have all the features you've been wanting at no increase in price.*

General Electric Company
Apparatus Dept., Sec. C730-9
Schenectady 5, N. Y.

Please send me—
Bulletin GEA-2234E on CR1061 Fractional-hp Motor Starters
Bulletin GEA-1522F on CR1062 Integral Motor Starters

NAME .....

COMPANY .....

ADDRESS .....

GENERAL ELECTRIC

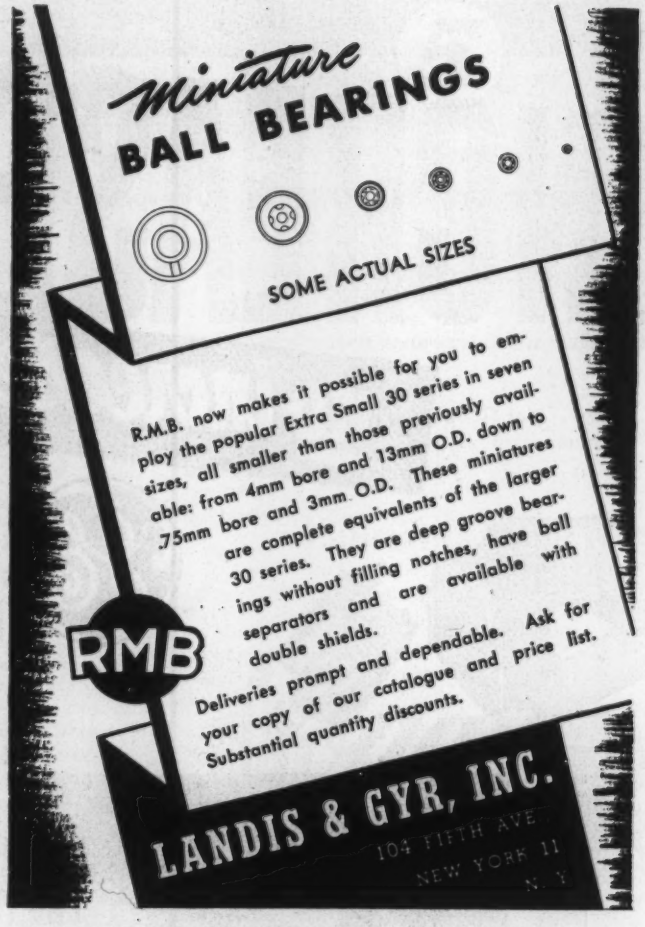
● Not unless you have Euclid's new "Curve-Flex" edgewound resistors. Their exclusive construction flexes and stretches with current surge and temperature rise. Yet never a sign of breakage or shorting. That means you eliminate costly down-time and save replacements with E. E. resistors.

Plated metal parts resist corrosion. And their wide open construction eliminates overheating. The special alloy resistor ribbon maintains constant resistance through wide temperature change. Expansion and contraction of the frame will never damage the porcelain, thanks to Euclid's exclusive expansion joint.

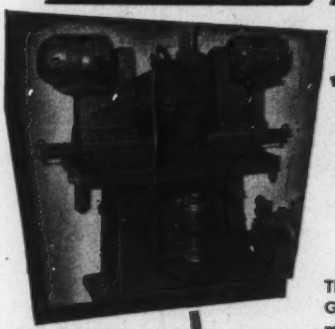
Choose "Curve-Flex" resistors in capacities from 1 to 75 amperes . . . in lengths from 9 to 24 inches in three-inch increments. Both clamp and brazed type terminals are available. Ask your E. E. representative for more information or write direct to:

CURVE-FLEX RESISTORS

The Euclid Electric & Mfg. Co.
MADISON, OHIO



Instantaneous Coolant Flow with



RUTHMAN GUSHER COOLANT PUMPS

Photo Courtesy
The Gardner Machine Co.

Illustrated is a typical installation of a Ruthman pump on a Gardner #77A - 12" Double Spindle Grinder. The specific pump illustrated is a Ruthman Model 11022.

There is no waiting with Ruthman Gusher Coolant Pumps. From the moment the machine starts you get copious coolant flow that can be controlled in a split second from a trickle to full volume. Ruthman Pumps do not build up pressure when throttled, there is no priming or packing needed.

Join the thousands of metal-cutting machine operators all over the country who know by experience that Ruthman Pumps give them better, more efficient service and long trouble-free life.

Write for literature today.

THE RUTHMAN MACHINERY CO.

1811 Reading Rd., Cincinnati, Ohio

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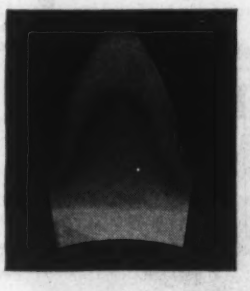
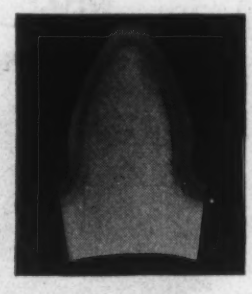
Westinghouse

Hard and Tough

this "taper-hardened" tooth bends before it breaks



Taper-Hardened Tooth Section



Case-Hardened Tooth Section

The taper-hardened tooth above bent under the same force that snapped the case-hardened tooth. Yet a test will show wearing surfaces of nearly equal hardness.

The cross sections at the left show why taper-hardened gears have resilience and life under their hard surfaces—why they last longer in punishing service—why they "roll with the punch". Notice the graduated hardness in the taper-hardened tooth—blending down the scale from maximum hardness at the surface to toughness at the ductile core. Compare it with the thin, brittle, shell-like hardness of the case-hardened tooth in which there is no give, no bend.

No wonder "taper-hardened" BP gear steel makes gears last so long.

For complete information on taper-hardening, write for free copy of "BP Gear Steel" B-4395, Westinghouse Electric Corp., Dept. 411, P. O. Box 868 Pittsburgh, Pa.

J-07276

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Yours for

PUSH BUTTON OR AUTOMATIC

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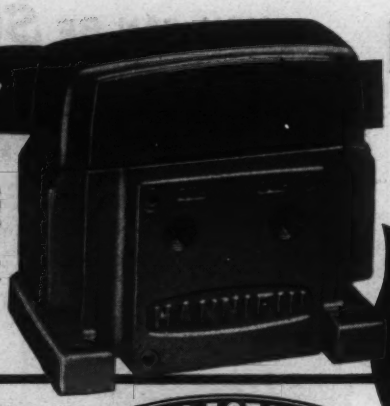

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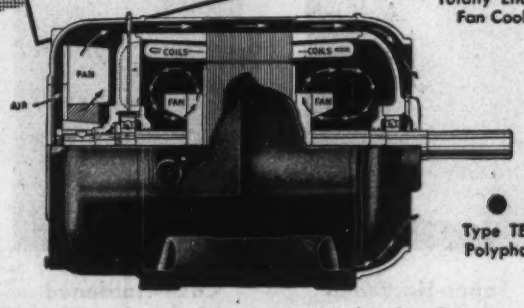
Productive FORMICA at Work in Industry

THE LATEST DEVELOPMENT in AIR COOLED Ball Bearing MOTORS



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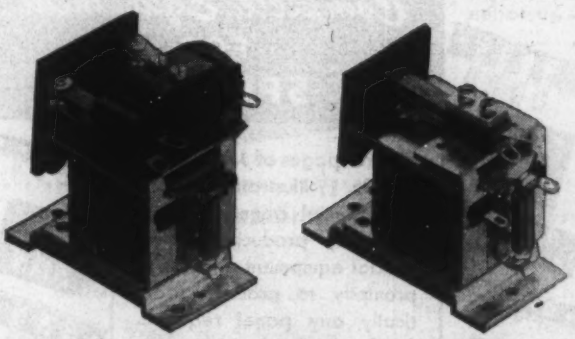

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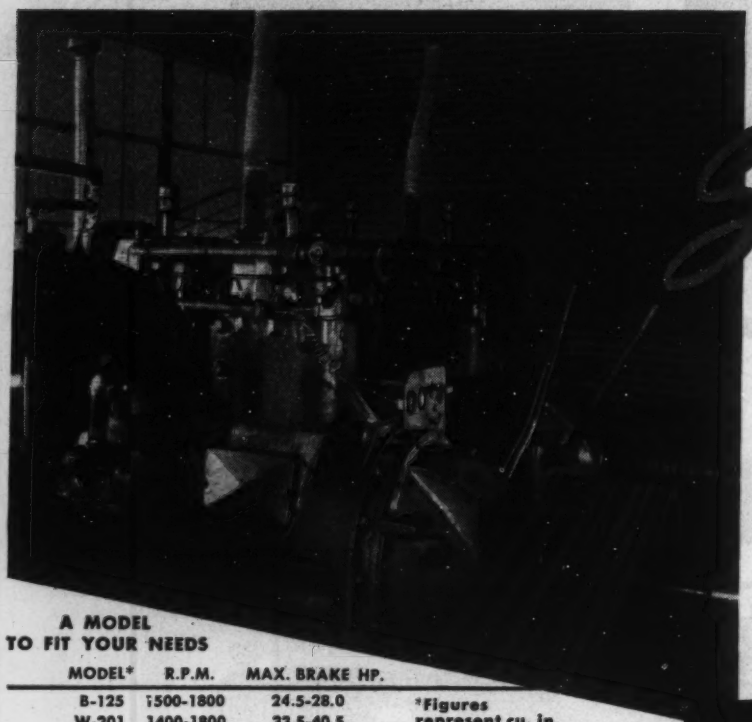

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It's the seventh anniversary of service for two Allis-Chalmers E-563 Power Units at the Town of Long Beach, Mississippi. These heavy-duty 74-hp. engines have been driving pumps day and night — alternating each week — to pile up a total of 60,000 hours of service together, 30,000 each. There has never been a major overhaul . . . and both are still in excellent running order!

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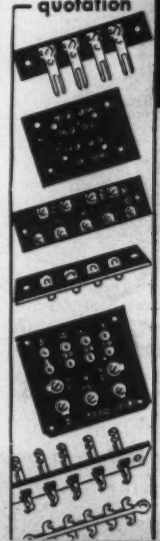

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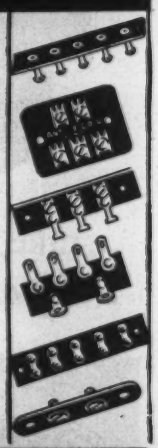

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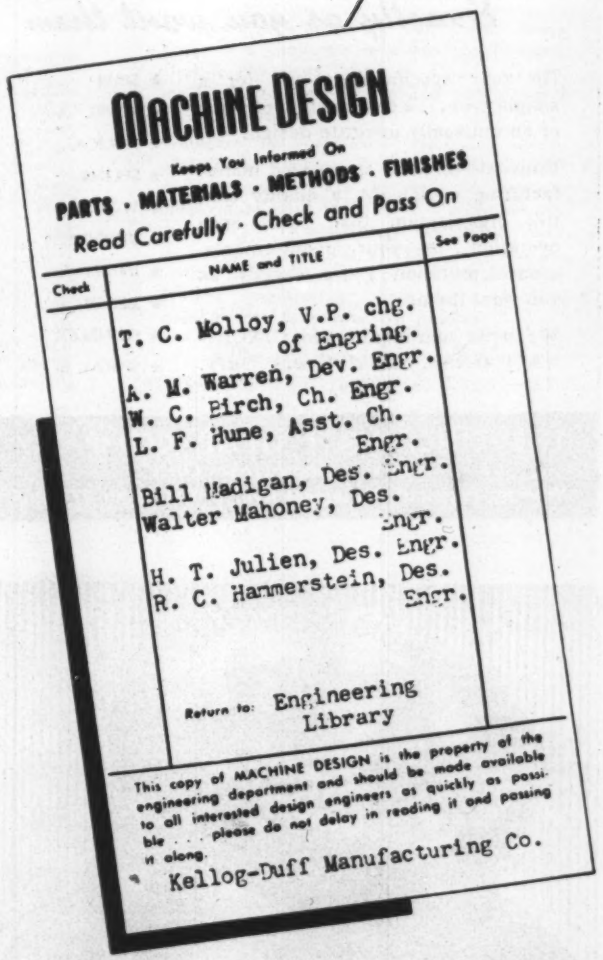

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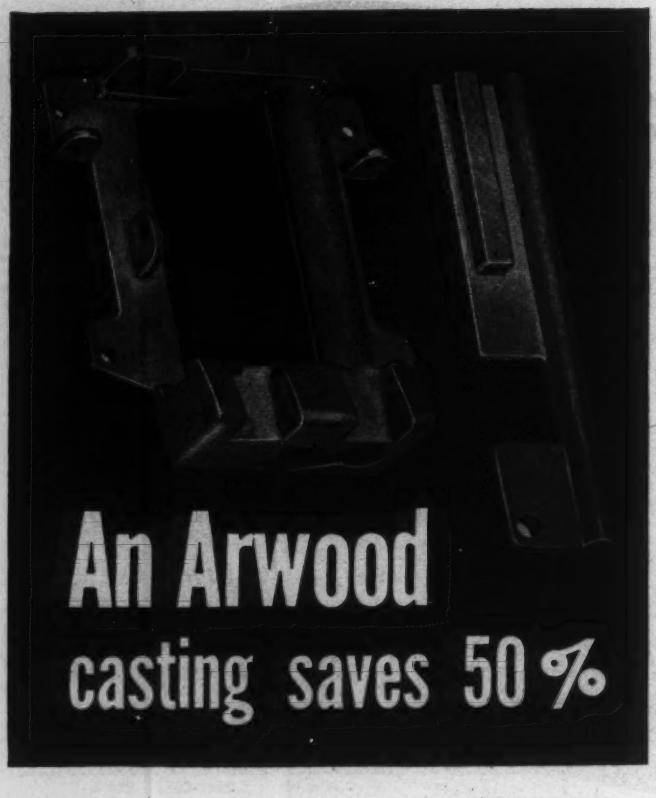

An Arwood casting saves 50%

Here is a typical example of what ARWOOD precision castings can do. Such results are made possible only by ARWOOD'S years of experience that spells "know-how."

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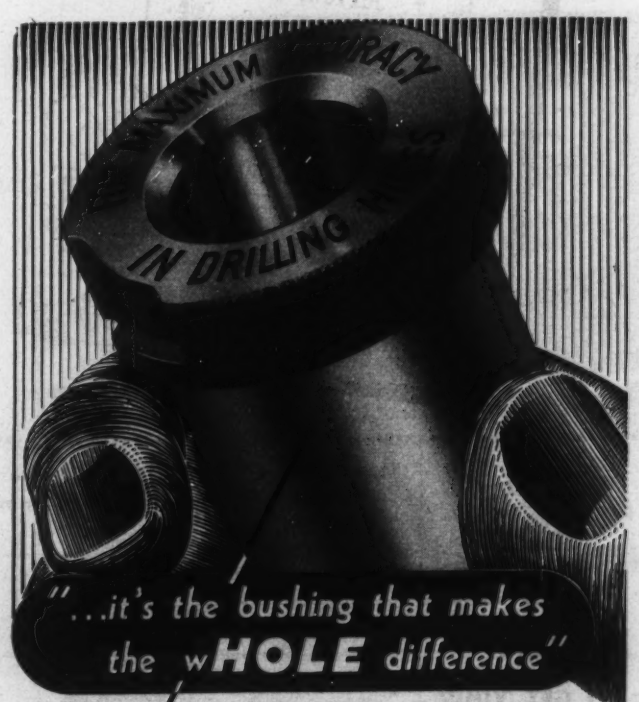

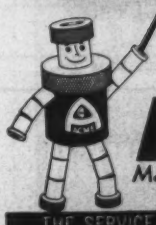

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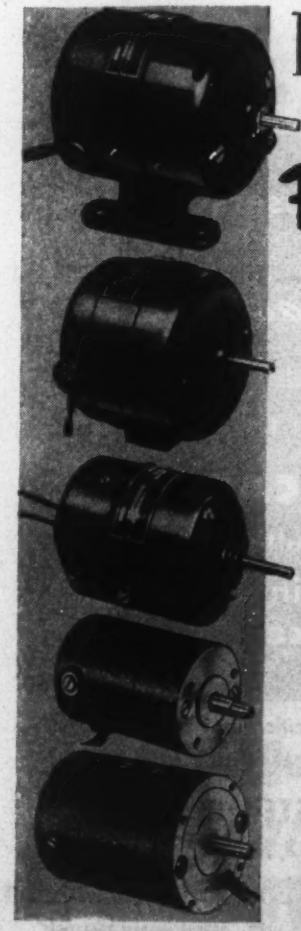

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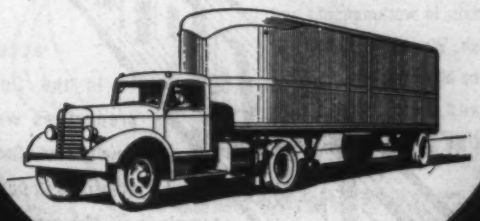

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SPERRY HYDRAULIC REMOTE CONTROL

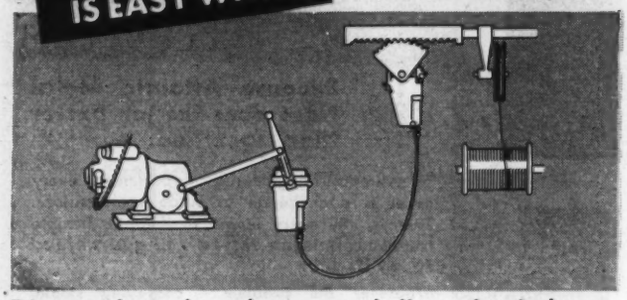

Diagram above shows how Sperry Hydraulic Remote Controls can be used to actuate wire-winding arbor on wire covering machine. A motor-driven Type F transmitter moves at a regulated speed. The receiver controls the level-wind mechanism on the arbor so wire lies smoothly. At the end of each stroke, the control is automatically synchronized.

Sperry Hydraulic Remote Controls are accurate. Working stroke of both the transmitter handle and the receiver lever is 55°. A single copper tube connects transmitter and receiver; easy to install and maintain. **For all the facts on Sperry Hydraulic Remote Control, write for Bulletin 2001. T-11** SP-152

SPERRY PRODUCTS, INC.
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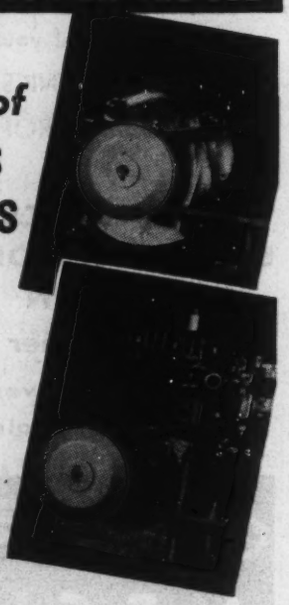
PUT A MERCURY CLUTCH ON THE JOB

for Easy Starting of
ELECTRIC MOTORS
GASOLINE ENGINES



In starting a direct-coupled motor the torque requirements are greatest and the motor the least effective in the first few seconds of starting time. Installed on an electric motor, a Mercury Clutch permits the motor to reach its full effective operating speed before the load is applied. RESULT: Lower current demand, trouble-free starting, no burned-out motors or blown fuses.

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MAKERS OF DOT FASTENERS

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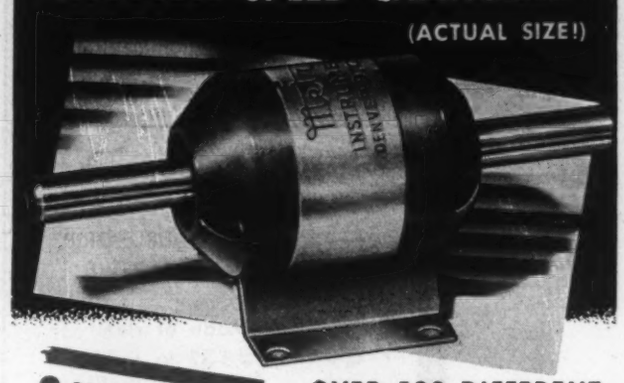
(ACTUAL SIZE!)



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- ADAPTABLE
- PRECISION-BUILT FOR QUALITY PRODUCTS

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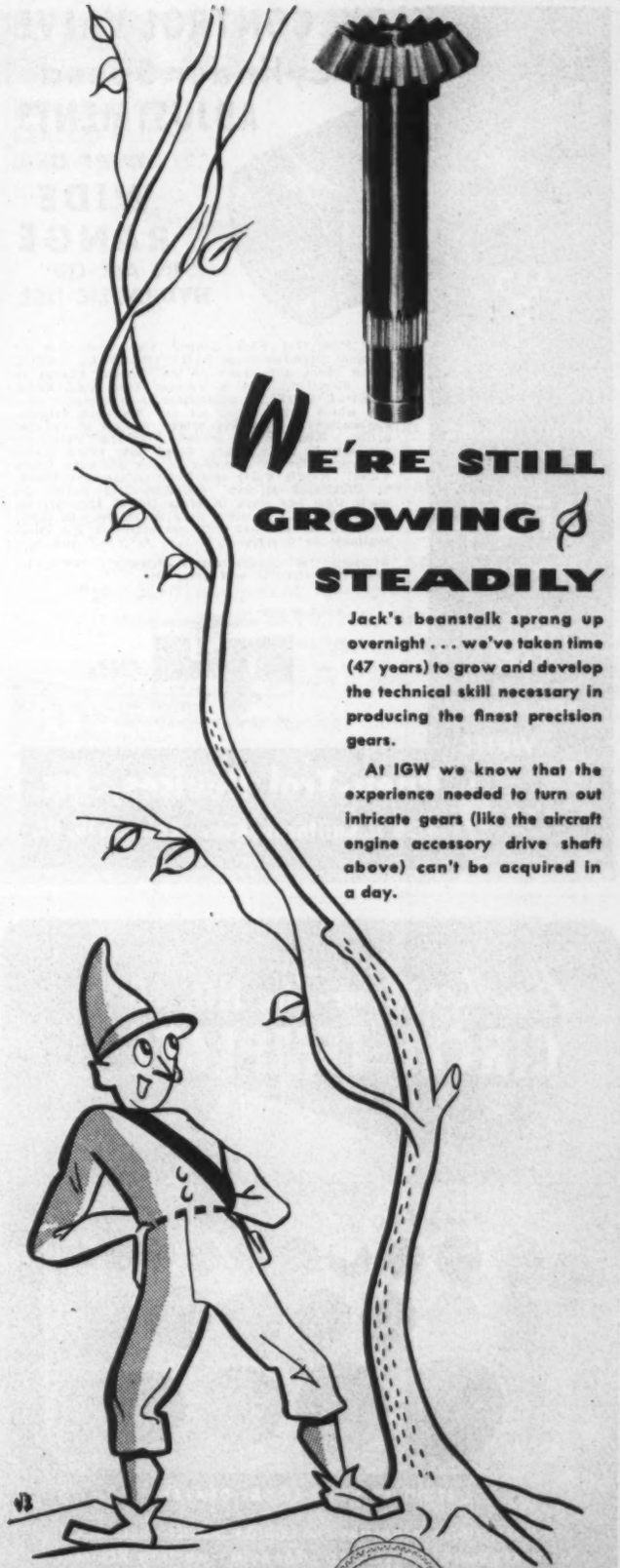

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Jack's beanstalk sprang up overnight . . . we've taken time (47 years) to grow and develop the technical skill necessary in producing the finest precision gears.

At IGW we know that the experience needed to turn out intricate gears (like the aircraft engine accessory drive shaft above) can't be acquired in a day.

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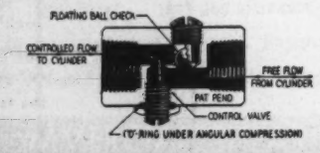

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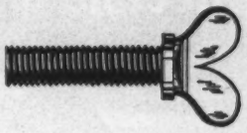
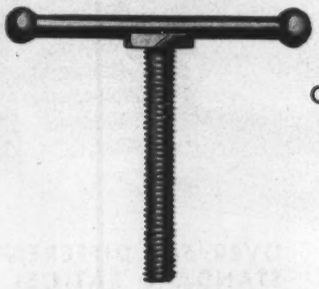
OHIO ADJUSTING SCREWS

Type ST Thumb Screws are made of steel or brass.
#10-32 to ½-20





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Made of steel
#8-32 to ½-13

Range of thread sizes shown for each part

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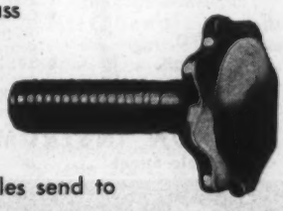

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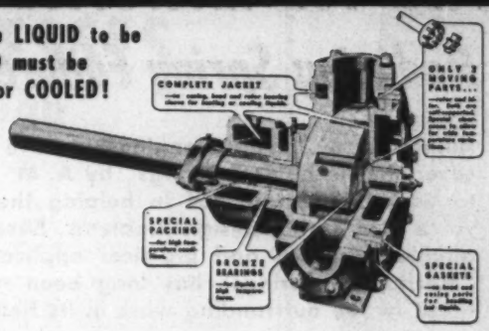

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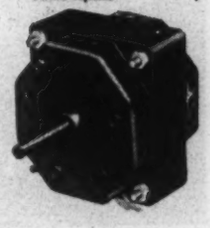

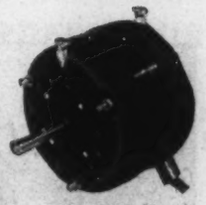

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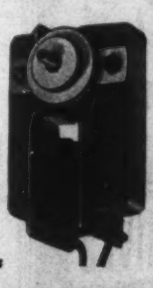

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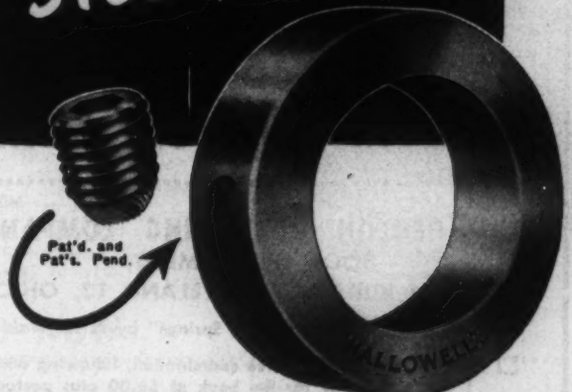

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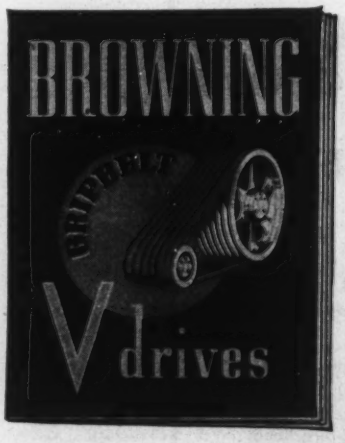

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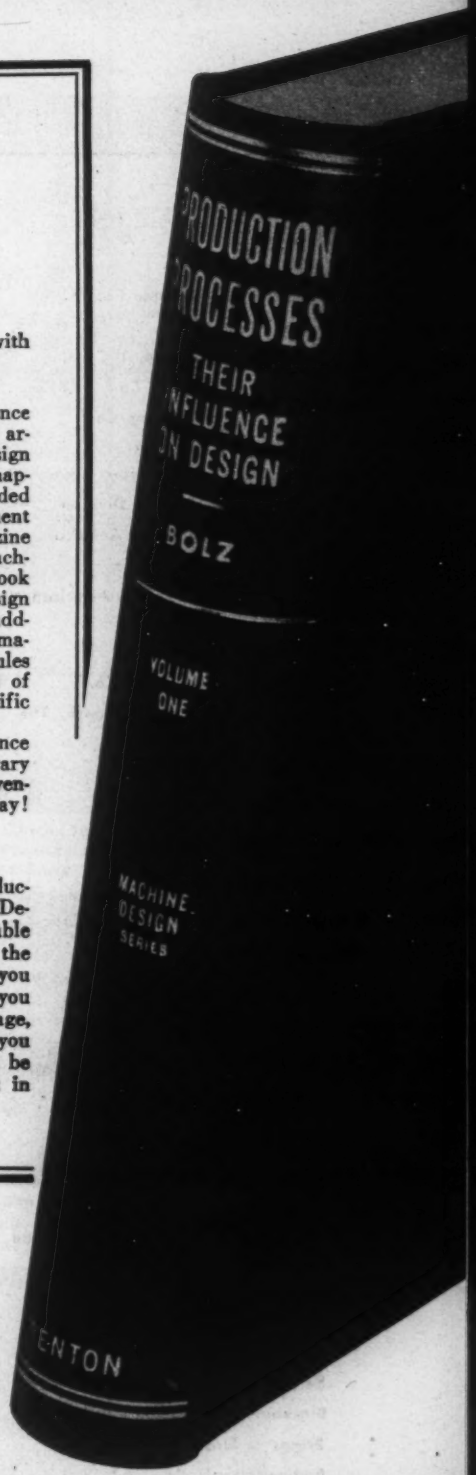

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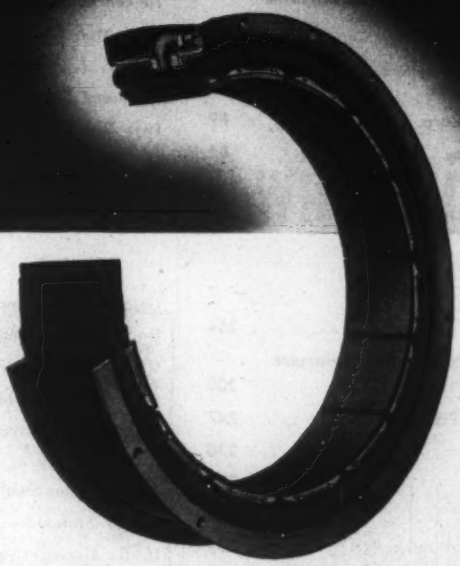

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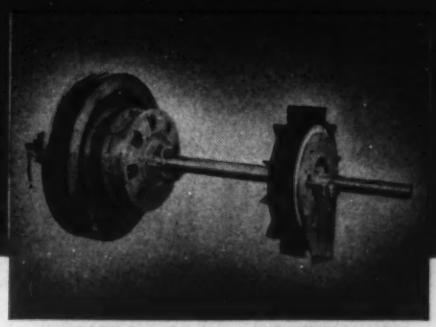

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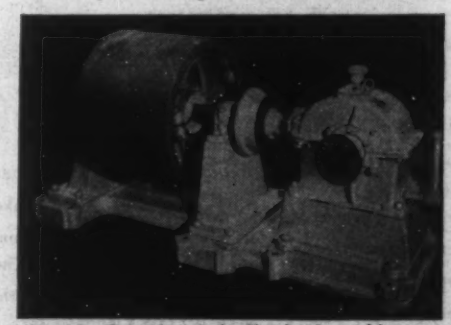

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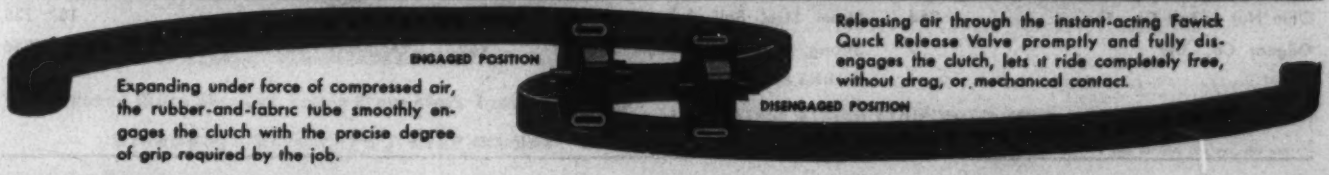

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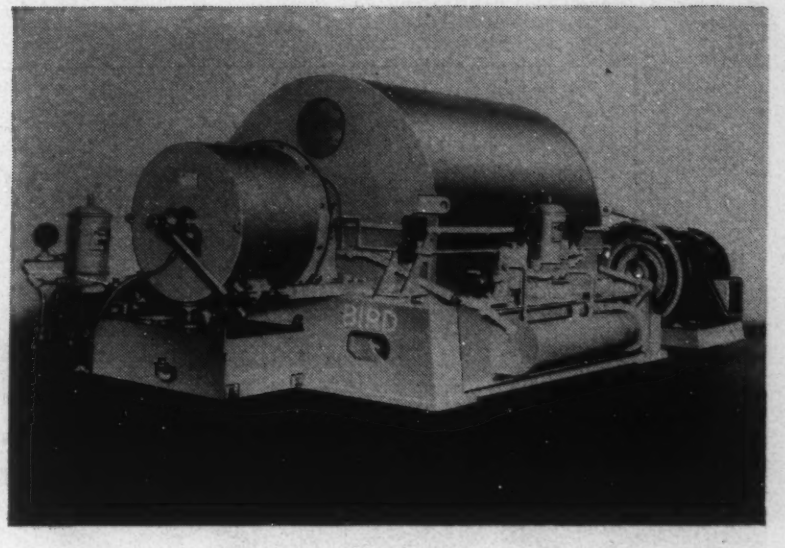

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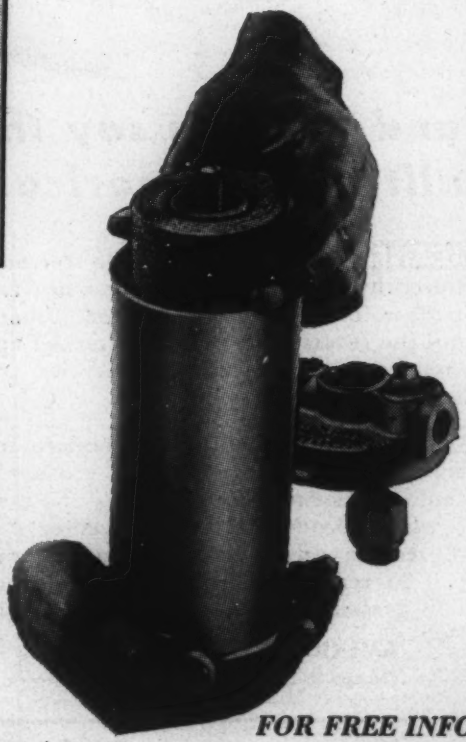

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Business Address.....

PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

"Clean As A Whistle"
TO MAKE and TO USE

...and you can say that of <u>any</u> vac built with American Phillips Screws

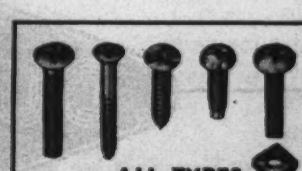
CLEANER PRODUCTION: No scarred parts, no slashed hands, no floors littered by fumbled screws. For when an American Phillips Screw is put on the point of its 4-winged driver . . . then they become one straightline unit until the recessed screwhead is turned up flush and tight . . . the *first* time, *every* time. Saves rejects, saves screws, *saves time up to 50% over out-of-date slotted screws.*

CLEANER SALES: Buyers of modern, top-quality products know the buy-sign of the universal Phillips crossed recess on everything from their automobiles to their golf clubs. To them, the Phillips recess means that when a product is so put together, *it stays put.* To you, it means fewer returns and fewer free servicings, especially where vibration is involved. So remember, from both viewpoints . . . production and sales . . . *American Phillips Screws always cost least to use.*

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
Chicago 11: 589 E. Illinois St. Norristown, Pa. Detroit 2: 502 Stephenson Building

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

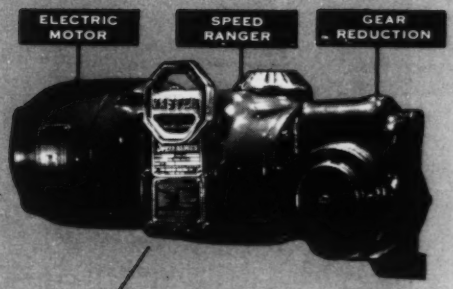
AMERICAN PHILLIPS *Screws*



ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

On thousands of applications in every field of manufacture, stepless variable speed operation assures exactly the right speed for every operation . . . for every operator . . . the right speeds for each change in the consistency or shape of the material being processed. Such variable speed operation pays off in higher rates of production, a more uniform better quality product and more efficient performance of your equipment and your operators.

Master Speedrangers provide this infinitely variable speed in an all-metal, mechanical variable speed unit whose compactness and durability are extra features which help you make a good job better. And nowhere else will you find variable speed drives that are so flexible, so easily adaptable and in such a wide range of types and sizes.



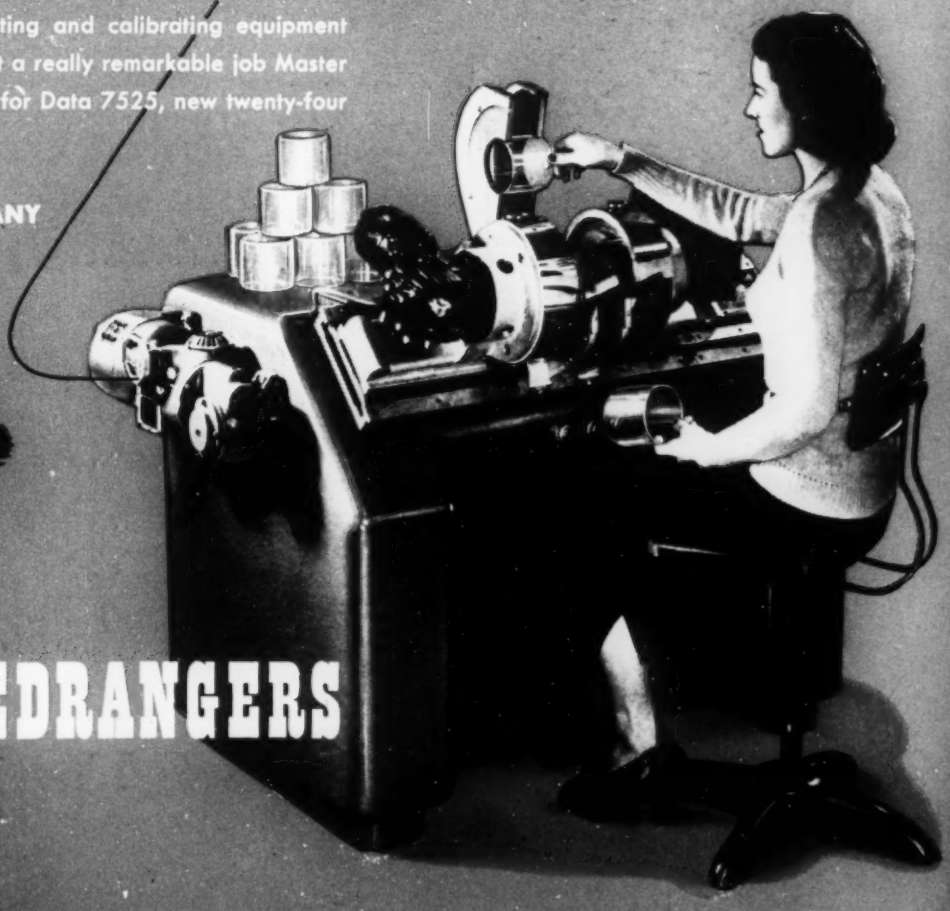
makes a good job better

again and again variable speed operation

For example, look at the plastic forming machine shown below. The Speedranger, on the drive unit incorporates an electric motor, a variable speed unit and a gear reduction . . . all standard Master units that easily combine into one compact, integral power package. This provides exactly the right speed, the right features, in a unit that you can mount right where you want it.

Probably you will not need this same combination of features. However, the next time you need a drive for material processing, handling, and conveying equipment; mixers and agitators; welding-positioners; machine tool drives; testing and calibrating equipment . . . to name only a few . . . see what a really remarkable job Master Speedrangers can do for you. Write for Data 7525, new twenty-four page booklet on Speedrangers.

THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO



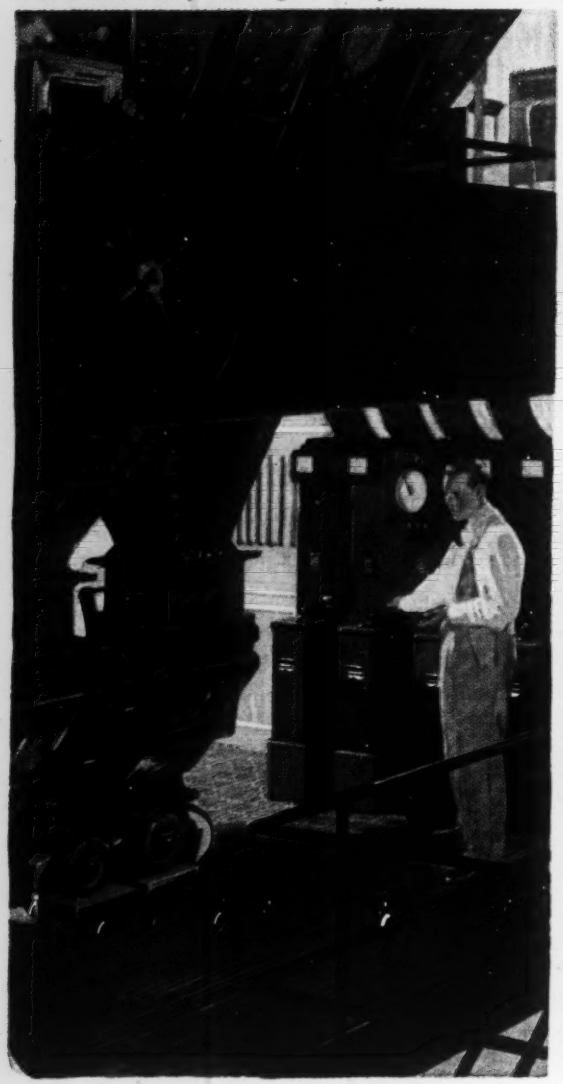
especially when you use

MASTER SPEEDRANGERS

There's only one way

To pulverize coal...

Electric motors directed by Cutler-Hammer control equipment do many jobs in modern power plants. Here shown is the control installation for one of two identical batteries of coal pulverizing machinery.



Process sewage...

The modern sewage disposal plant is a model of quiet efficiency and impressive cleanliness, thanks to scores of busy but unseen electric motors. Here is shown a typical Cutler-Hammer main control board.

Or punch out parts...

Whatever the work to be done, it's a job for an electric motor and dependable control. Shown is a standard unit of C-H general purpose motor control (Bul. 9586) and push button (Bul. 10250).

There may be a number of ways to skin a cat but there's no confusion as to the way to get industry's jobs done in a hurry without backbreaking toil and profit-eating waste. That *one* way is with electric motors. America's industrial establishments today employ more than *ten million* electric motors.

This fact in itself is impressive proof of the importance of motor control equipment. Each of those ten million motors was purchased and installed to provide a definite *needed* service. And obviously no electric motor can perform its assigned task properly and dependably without the direction and protection of adequate and dependable motor control.

Cutler-Hammer general purpose motor control is recommended by a majority of all electric motor manufacturers, is featured as standard equipment by machinery builders, is carried in stock by recognized electrical wholesalers everywhere.

CUTLER-HAMMER
MOTOR CONTROL
C-H

For more than fifty years Cutler-Hammer engineering has recognized the vital need for *dependability* in motor control.

It has put such famous features as dust-safe contacts and eutectic element overload protection into even the smallest units of C-H Control to establish performance records that today make the name Cutler-Hammer the specified choice of engineers everywhere. CUTLER-HAMMER, Inc., 1310 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.